



ANNUAL
REPORT
2009



BOARD MEMBERS

Dr J.W. Stocker AO BMedSc, MBBS, PhD, FRACP, FTSE
Chairman—Elected a member under Clause 25.2(d)
of the Constitution (from 1 January 2009)

Mr J.F. Brayne, BAppSc(Wine Science)
Elected a member under Clause 25.2(d)
of the Constitution (from 1 January 2009)

Mr P.D. Conroy, LLB(Hons), BCom
Elected a member under Clause 25.2(c)
of the Constitution

Mr P.J. Dawson, BSc, BAppSc(Wine Science)
Elected a member under Clause 25.2(d)
of the Constitution

Mr G.R. Linton, BAppSc(AppChem), GradDip (SysAnal)
Elected a member under Clause 25.2(d)
of the Constitution

Mr B.M. McKinnon, BAgSc(Oenology) (Hons)
Elected a member under Clause 25.2(d)
of the Constitution

Ms J.S. O'Connor, BEd(PE)
Elected a member under Clause 25.2 (c)
of the Constitution

Mr M.R. Watson, BEc, MBA, ACA, IPAA
Elected a member under Clause 25.2(c)
of the Constitution

Mr J.A. Lumbers, BSc(Microbiol); Lit B(Public Policy)
Elected a member under Clause 25.2(d)
of the Constitution (from 1 January 2009)

Professor I.S. Pretorius, BSc(Hons), MSc, PhD
Ex officio under Clause 25.2(b) of the Constitution
as Managing Director of the AWRI

Mr T.W.B. James, AssDip(Wine Prod)
Elected a member under the clause 25.2(d) of the
Constitution (until 31 December 2008)

Mr R.E. Day, BAgSc, BAppSc(Wine Science)
Chairman – Elected a member under clause
25.2(d) of the Constitution
(until 31 December 2008)

Mr J.S. Webber, BAppSc(Wine Science)
Elected a member under clauses 25.2(d) and 27.1
of the Constitution (until 31 December 2008)

THE COMPANY

The Australian Wine Research Institute Ltd was incorporated on 27 April 1955. It is a company limited by guarantee that does not have a share capital.

The Constitution of The Australian Wine Research Institute Ltd (AWRI) sets out in broad terms the aims of the AWRI. In 2006, the AWRI implemented its ten-year business plan *Towards 2015*, and stated its purpose, vision, mission and values:

Purpose

To contribute substantially in a measurable way to the ongoing success of the Australian grape and wine sector

Vision

To deliver high value to the Australian grape and wine sector through world-class research and integrated solutions and to provide thought leadership to the research activities of the Australian wine sector

Mission

To underpin our world-class research and integrated solutions with:

- » a tenacious pursuit of understanding;
- » the development of a unique, extensive and usable knowledge base; and
- » a focus on contributing substantially to stakeholders achieving their needs

AWRI's values provide guidance in how it will deliver on its mission. These *values* are:

- » scientific integrity and excellence;
- » a culture of delivering results;
- » internally and externally collaborative;
- » accountability and transparency; and
- » focused on the Australian wine sector and industry driven

The AWRI's laboratories and offices are housed in the Wine Innovation Central Building of the Wine Innovation Cluster (WIC). The WIC is located within an internationally renowned research cluster on the Waite Precinct at Urrbrae in the Adelaide foothills, on land leased from The University of Adelaide. Collocated in the Wine Innovation Central Building with the AWRI is grape and wine scientists from The University of Adelaide and the South Australian Research and Development Institute. The parties in the Wine Innovation Cluster, who are accommodated over three buildings, include also CSIRO Plant Industry and Provisor Pty Ltd.

Along with the WIC parties mentioned, the AWRI is clustered with the following research and teaching organisations: Australian Centre for Plant Functional Genomics (APFG), Australian Genome Research Facility (AGRF), Australian Grain Technologies (AGT), Australian Wheat Management, BiometricsSA, three divisions of CSIRO, Department of Water, Land and Biodiversity Conservation, Primary Industries and Resources South Australia (PIRSA), Membrane Transporter Expression Facility, VivoPharm, Lifeprint and The University of Adelaide's *School of Science* (which includes the Schools of Agriculture and Wine, and Earth and Environmental Sciences).

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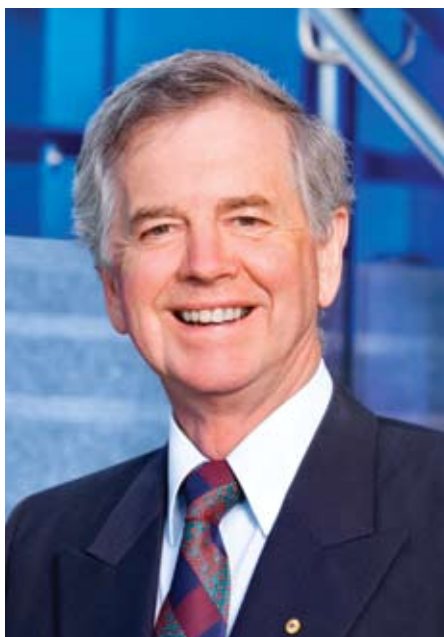
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55th Annual Report
30 June 2009

Presented to the Australian
grape and wine sector



Chairman's report

It is with pleasure that I prepare my first report as Chairman of The Australian Wine Research Institute. In stepping into this role, I had a good appreciation of the contribution the AWRI makes to the Australian grape and wine sector. Part of this understanding comes through establishing and managing a vineyard in the Goulburn Valley; from my time as Chairman of the GWRDC; and from participating in the AWRI's Strategic Planning Day, the outcomes of which became the basis for the AWRI's current business plan. This business plan was implemented in 2006 under the Chairmanship of Robin Day. Under Robin's guidance, the AWRI delivered some fine outcomes of benefit to producers; contributed to the body of knowledge of wine science; and helped ensure the sustainability of this industry's innovation company. One most noteworthy achievement I wish to acknowledge is the role Robin and his board played, with the current and immediate past Managing Directors, in the establishment of the Wine Innovation Cluster.

The AWRI's Business Plan set a strategic direction for the company from 2005 to 2015. The Plan elucidated the strengths, weaknesses, opportunities and threats surrounding the AWRI's financial and human resources; infrastructure; structure; and governance. Ten key initiatives were identified as crucial to the ongoing sustainability of the AWRI. The establishment of the Wine Innovation Cluster, a new home for the AWRI, was one of the initiatives; the strengthening of the AWRI's corporate governance is another. The shape of the AWRI's Board has been evolving. The Board is now comprised of members with complementary skill sets, which cover the range of abilities required for good

modern corporate governance. Each of our Board members is enthusiastically engaged in providing support to ensure the long term sustainability of the AWRI. Next year, the Business Plan timeline hits the half-way mark. Our Board will be proactively reviewing the objectives and strategies in the Business Plan to ensure the 'roadmap' continues to lead us in the right direction.

The business model of the AWRI, where the researchers, developers, extension and commercialisation specialists work closely together, puts us in a strong position to deliver to stakeholders. When one considers the evolution of science, it is clear from numerous state-of-the-art writings and practical experiences in today's 'borderless world' that science has grown far more heterogeneous over the last few decades – it's now thoroughly *academic, industrial and entrepreneurial* in nature. Research, Development, Education/Extension, Commercialisation, Implementation and Innovation, as practised as a seamless, integrated and interactive enterprise, is by far the most efficient and effective way to reap the fruits of science and to gain the maximum return on investment in research.

With an effective business model in place, a 'grassroots' assessment of the quality of the AWRI's scientific output is logical. Recently, the citation performance of the AWRI's publication output was assessed and compared to South Australian, Australian and world benchmarks in relevant disciplines. This bibliometric analysis was undertaken by the Research Evaluation and Policy Project (REPP), Australian National University, for The Australian Wine Research Institute. The analyses used several standard bibliometric measures: citations per publication; relative citation and journal impact; and centile distribution of publications. Whilst we see the results of our research being applied by our grape and wine producers, it is equally satisfying to have a quantifiable assessment of the quality of our science. I highlight a few of the main results of the analyses:

- » Total AWRI publications indexed in Web of Science (WoS) have increased by 87% during the recent period 2004-07 compared with the 2000-03 period. Increased output was noted for almost all fields and subfields.
- » Publication output in the Biological Sciences field has nearly tripled between the two time periods analysed. This increase is due to the strength in subfields of Microbiology and Biotechnology.
- » Citations per publication (CPP) and relative citation impact (RCI) have increased over the recent years in all the three fields analysed in this study: Chemical Sciences; Biological Sciences; and Engineering and Technology.

- » CPP rates are strong for the fields of Chemical Sciences, and Engineering and Technology, above the world, Australian and South Australian averages.
- » The AWRI performs well in journals related to its core research areas. Both citation impact and journal impact are higher than the world benchmark. **The AWRI's citation impact is almost 50% higher than the world benchmark and well above Australian and South Australian averages.**
- » Increased citation performance in core journals is also reflected in the proportionately higher number of highly cited publications for the AWRI compared to South Australia and Australia. **The AWRI has published 3 of the 13 most highly cited Australian publications which are amongst the top 1% in the world in these journals.**
- » Relative to the AWRI's publication share, more of its publications appear in the top 1%, 5% and 10% clusters, compared to South Australia and Australia.

With our producers facing continuing challenges to their businesses, the AWRI continues to seek to apply leading-edge science capability to its research – to increase its speed of delivery of meaningful results. A major hurdle for scientists attempting to access the 'big science' necessary to do research using new disciplines such as 'Systems Biology' is that it requires a broad range of expertise and state-of-the-art (and very expensive) resources. Typically, no one single laboratory can afford such resources, requiring researchers to work in large consortia, collaborating to achieve a common goal. The AWRI has been active in this area. The Australian Government has funded the development of four service delivery platforms: Genomics Australia, Proteomics Australia, Metabolomics Australia (part of which is housed at the AWRI) and Bioinformatics Australia (which provides computing infrastructure). The activities of these four platforms, whilst largely autonomous, are overseen by Biopatforms Australia. In a coup for the Australian wine sector, Biopatforms Australia has adopted wine yeast as a model to demonstrate how we can do Systems Biology in this country, with the AWRI leading and coordinating this proof-of-concept study.

Collaboration is a badge the Australian wine sector, including its research community, has worn with pride internationally. Based on my knowledge of at least two of our main grape and wine research agencies, there are considerable collaborations happening. For example, the AWRI has over 70 contractual collaborations and hundreds of other active research collaborations the world over at



the present time. Successful collaborations, such as those engaged in by the AWRI and fostered in the Wine Innovation Cluster, allow the collaborating groups to maintain their own identity and achieve their own vision and goals while achieving the collaborative goals at the same time. Collaboration is essential and is at the heart of what we do. There is a danger that collaboration could be perceived as 'not happening' within our sector's grape and wine research community, if partner organisations don't morph into a large 'beige, centralised' melting pot. We should neither encourage nor expect 'beige thinking and centralism' within our grape and wine research community. Collaboration within the Wine Innovation Cluster, and among the scientists and grape and wine technicians more broadly, is bringing together the best minds from the science and art of winemaking from across the nation. Just eight months after the five WIC partners (AWRI, the University of Adelaide, the South Australian Research and Development Institute, CSIRO Plant Industry and Provisor Pty Ltd) began working together, they have already developed a way to advance our knowledge and expertise in the area of drought resistant crops.

There are now multiple projects involving the WIC partners: the new AWRI Metabolomics Facility is another case in point. Metabolomics is a new, exciting area of research investigating complex biological systems, where metabolites – in our case, the compounds produced by grapevine and yeast metabolism – are measured in order to explain characteristics that we recognise in wine. Metabolomics combines analytical chemistry with bioinformatics to provide insight into the composition, flavour and aroma of wine: an example is to predict the consequences of redirecting sugars away from ethanol formation during yeast fermentation – thus fast tracking the selection of 'low alcohol' yeasts.

Located in the WIC, the \$2M AWRI Metabolomics Facility is a nationally-networked organisation. This facility helps build the infrastructure required to support new discoveries in this emerging area. It is another example of how the WIC is giving Australian wine research a head start, and using collaboration to make its findings nationally available and relevant.

I encourage you to read the AWRI's annual report for 2009, and I look forward to working with the Board members and with Sakkie and his first-class team to create a strong AWRI that delivers exceptional outcomes for Australian grape and wine producers.



Dr John Stocker AO
Chairman of the Board





Managing Director's report

Value through vision

It has been a year of discoveries and revelations. At The Australian Wine Research Institute, our advances in research, development and extension, along with our efforts to commercialise our knowledge, have created even more opportunities for companies to innovate. But for the sector as a whole, it has been a year of sobering revelations: we have been hit hard by the global financial crisis (GFC), the consequences of climate change, the sudden change in attitude towards Australian wine in some quarters, the threat of taxation increases and the fluctuating Australian dollar.

Last summer saw the hottest days on record in vineyard after vineyard from the Yarra Valley to the Barossa. The start of 2009 was also the driest on record, marking Australia's longest and most devastating drought. Victoria experienced its worst bushfires in 100 years, while flooding hit Queensland. If this is the impact on the Australian wine sector of global climate change, we have a challenging future ahead.

The world's financial climate also made its mark. Sales were squeezed in an already crowded market, and consumer trends were influenced by the credit crisis. But while reaction to the GFC has gathered pace, the response to climate change is still slow. The world has been overwhelmed by doomsayers or has sought refuge in complacency: believing that science, somehow, will find a 'silver bullet' to solve the problem.

At the AWRI, however, we neither believe the doomsayers nor trust in silver bullets. Instead, we believe in sustained innovation and commitment to a profitable, environmentally responsible sector. Where others see adversity, we see opportunity.

This year, we have stayed true to our vision, seeing the Australian wine sector through two lenses, not just one. We have continued to work towards our vision of contributing substantially to the ongoing success of the Australian wine industry: an industry built on a sustainable foundation. We have set our sights on both environmental responsibility and profitability.

A collaborative cluster

The Australian Wine Research Institute relocated to its new building as part of Australia's Wine Innovation Cluster (WIC) in October 2008. Collaboration within the WIC and, more broadly, among Australia's grape and wine researchers, has brought together the best minds from the science and art of winemaking from across the nation.

Drawing on a history of collaborative success, the WIC partners are taking collaboration within the Australian wine sector to another stage in development and productivity. Built on trust and the pursuit of mutual benefit, the WIC is already proving itself to be more than just a building. Less than a year since the collaboration started work, progress has been made in tackling environmental issues, with the potential to transform the Australian wine sector.

Combining their resources, the WIC partners have developed a way to advance our knowledge and expertise in the area of drought resistant crops. A collaborative study is underway to integrate different methods to assess and manage water in the vineyard. As part of this project, the AWRI is developing a method based on near-infrared (NIR) spectrometry combined with multivariate analysis that will relate NIR absorption spectra with physiological measures of leaf water status in field grown Shiraz, Cabernet Sauvignon and Chardonnay grapevines. Preliminary NIR calibrations yielded good correlation coefficients between predicted and measured stem and leaf water potential. These correlations appear to hold within a variety for several weeks of measurement. It is also possible to determine clear trends in the spectra that might soon enable rapid detection of the onset of water stress.

As a WIC partner, the AWRI draws on its own history of constructive collaboration. When the wine sector and wine researchers decided to join forces in 1955 to establish the AWRI, they did not know what the outcomes would be. They knew, however, that there was a need to pool resources, ideas and expertise to create something new: a body of people that would, in turn, create a body of knowledge.

Today, that knowledge, embodied by the AWRI, provides the Australian wine sector with unparalleled support services and technical knowledge, enabling the transfer of technology into everyday practices. It is a success story of collaboration that continues to inspire other wine-producing countries, who long for a similar, industry-owned centre for technical expertise and innovation.

A collaborative climate

The WIC is not the only example of collaboration in action: the AWRI has continued to work both nationally and internationally to pursue its vision of industry sustainability through innovation.

Its collaborations have set out to create value through knowledge, delivering new opportunities as well as scientific discoveries. Internal and external collaboration is a critical component of every project undertaken at the AWRI. Four of many possible examples are shown below.

- » Our work to understand smoke taint in grapes and wine took high priority this year, following major bushfires across Victoria. Method development to obtain a quantitative measure for 'total guaiacol precursors' is in progress. In collaboration with researchers from the University of Adelaide, wine will be made from grapes sampled in 2009 at various smoke-affected vineyards in Victoria and used to test the various methods under development.
- » In order to contribute more effectively to the sustainability requirements of grape and wine producers, the AWRI, together with the Australian Government and the University of Adelaide, has started a project to evaluate grape marc and stalks as a biomass fuel source for renewable power generation.
- » The first formal node of the AWRI was established in Tasmania, enabling collaboration with the Tasmanian wine sector and the conduct of regionally-relevant research programs. This forms a model for the formation of AWRI nodes in other regions.
- » The AWRI and the Institute of Masters of Wine formed a joint venture aimed at better integration of the two groups' advanced wine education programs.

Scientific excellence and quality assurance

Throughout this year, the AWRI has maintained its reputation for scientific excellence. Our publications, for example, were benchmarked on a global scale by the Research Evaluation and Policy Project of the Australian National University (ANU). In an assessment commissioned by the AWRI, the scientific impact of publications for the period 2002-2007 was assessed using bibliometric analysis.

The ANU report, which outlines the methodology used and its findings, noted that the AWRI performs well above global, Australian and South Australian benchmarks. It also referred to a list of 37 journals used most often by the wine research community to publish findings, stating that 'three out of the 13 Australian publications that appear in the top 1% of world output are AWRI publications.'

This recognition was part of a bigger picture marked by key research findings. The 36 outcomes highlighted later in this report include the following:



» The full genetic sequencing of the genome of the malolactic bacterium *Oenococcus oeni* strain AWRI B429, following last year's world-first achievement in completing the genome sequence of a wine yeast. The sequenced *O. oeni* strain was selected on the basis of its genetic fingerprint and a previously observed positive influence of fruity and berry characters following malolactic fermentation (MLF) in red wine. This is a milestone on our journey towards our long-term goal of relating genomic differences to phenotype attributes, especially MLF performance and sensory impact.

» The confirmation that proteins responsible for protein haze can be hydrolysed at winemaking temperatures by a protease (BcAP8) from *Botrytis cinerea*. This is a significant accomplishment considering that such a protease has been actively sought by research groups all over the world since the 1960s. The objective of this project is to reduce the need for, and cost of, bentonite fining of white wines.

» The analysis of low molecular weight sulfur compounds, successfully advanced from validation to routine application, is now widely utilised for closure and shelf-life trials, yeast development projects, and for external clients. We are now able to selectively and accurately quantify, using labelled standards, the important thiol precursors cys-3-MH, glut-3-MH, cys-4-MMP and glut-4-MMP.

» The AWRI's efforts in cutting-edge science were furthered through the opening, by the South Australian Minister for Science and Information Economy, of the South Australian node of Metabolomics Australia, based at the AWRI.

» We published the first report linking the production of a comprehensive group of volatile sulfur compounds to nitrogen supplementation of grape must.

20:20 vision through green-tinted glasses

In last year's report, I explained the AWRI's innovation RDE&C model, which can be viewed as a three-dimensional pyramid with four apexes: Research (R), Development (D), Extension (E) and Commercial (C) services.

Today, we are using this model to deliver our vision for an Australian wine sector that is both environmentally and economically sustainable.

But why have a vision? Envisioning the future is something the human mind often struggles with. As organisational theorists know only too well, the human mind prefers to see things in terms of what it knows, what it has experienced and what is already familiar. True vision, however, requires a leap of faith as well as reason – it reflects the things we feel most strongly about, our values, not just our intellect.



In 1961, when President John F. Kennedy told congress that the United States would land a man on the moon before the end of the decade, some called it lunacy. The idea seemed preposterous; neither the science nor the technology was in place to respond to such a challenge. But his vision was a trigger. In the years that followed, the best minds in mathematics, science and technology brought their collective wisdom together and found a solution. The rest, as we know, is history.

The Australian wine sector also needs clear vision and direction. To motivate people to act with a real sense of urgency, its vision cannot dwell on doom and gloom, and must inspire more than just words. It must also use a different language, discarding talk of 'trade-offs' and 'sacrifice'; where ecological health is offset against economic loss.

In the AWRI's vision, one seen through green-tinted lenses, economic stability and environmental sustainability go hand in hand. They become a profitable partnership that is carefully maintained by collaborative, constructive action. This change of lenses allows us to see environmental sustainability and profitability as mutually dependent. Gone is the assumption that 'going green' loses money.

Farewell to a visionary... and 'welcome aboard' to another

In talking of vision and leadership, it is timely to acknowledge Robin Day's contribution to the AWRI over the past 22 years as a Board member. Robin stepped down as Chairman of the AWRI Board in December 2008, a role he held from 2001. Under Robin's guidance as Chairman the AWRI became even more responsive to the needs of the Australian grape and wine sector.

There were 'world-firsts' in the AWRI's research program; the development of many relevant and applicable technical capabilities; an expanded extension program; and the AWRI's business focus strengthened. Such focus led to major grants, thereby multiplying industry levy dollars.

Our Board membership has continued to reflect our desire for stronger corporate governance. In the past year, the AWRI's constitution underwent a major review designed to bring it in line with modern corporate governance principles and increase the ability of the AWRI to meet the needs of the sector it serves. I thank our Board for their hard work and diligence in achieving these and other outcomes.

Dr John Stocker AO assumed the role of the AWRI's Chairman, after Robin, and already we are seeing the benefits of his combined corporate and scientific experience. John's professional career features an enduring involvement with the wine sector both as a vineyard owner and member of national bodies, as well as long periods of involvement in the broader scientific and business communities. The AWRI is very fortunate to have a Chairman of John's stature to guide us through the coming years.

Finally, I wish to pay tribute and thank every member of Team AWRI whose skills, expertise, dedication, full commitment and daily work are at the core of the AWRI's ongoing success. It is a real privilege to lead such an inventive team with an unrelenting enthusiasm to discover, collaborate, deliver, support and care.

Looking ahead, we see a vision backed by leadership, collaboration and a successful integrative RDE&C model for innovation. From this foundation, we, at the AWRI, take our role seriously as thought leaders and change agents. We look forward to the continuing delivery of innovation that will firmly underline the sustainability of grape and wine production businesses and the environment that supports us all.

I urge to you to read the review of outcomes of the AWRI over the past year, all of which are summarised in this report.

A handwritten signature in black ink, appearing to read 'Sakkie Pretorius'.

Professor Sakkie Pretorius
Managing Director





The AWRI Board (left to right)

Front row: John Stocker, Sakkie Pretorius and Jan O'Connor

2nd row: Paul Conroy, Jim Lumbers

3rd row: Mark Watson, Peter Dawson

Back row: Jim Brayne, Geoff Linton, Brett McKinnon

Board notes

Chairman

At the Board Meeting held on 3 March 2009, Dr J.W. Stocker AO was elected Chairman of the Board.

Alternate Directors of the Board

Mr N.P. Blieschke

Mr A.N. Sas

Audit Sub-Committee

Mr P.D. Conroy

Mr J.A. Lumbers

Mr M.R. Watson

Remuneration and Nomination Sub-Committee

Dr J.W. Stocker AO

Mr P.J. Dawson

Mr G.R. Linton

Meetings

Ordinary General Meeting

The 54th Ordinary (Annual) General Meeting was held on 18 November 2008.

Special General Meeting

n/a

Board

The Board of the AWRI met on the following dates:
19 August 2008, 18 November 2008, 3 March 2009,
19 May 2009.

Funding

The Board of the AWRI acknowledges the continuing financial support of the Grape and Wine Research and Development Corporation.

Appreciation

The AWRI acknowledges the assistance and cooperation of the following organisations throughout the year:

[Australian Society of Viticulture and Oenology](#)

[Australian Wine and Brandy Corporation](#)

[Charles Sturt University / National Grape and Wine Industry Centre](#)

[Commonwealth Scientific and Industrial Research Organisation \(CSIRO\)](#)

[Department of Agriculture, Fisheries and Forestry](#)
[Department of Innovation, Industry, Science and Research \(DIISR\)](#)

[Department of Premier and Cabinet \(SA\)](#)

[NSW Wine Industry Association Inc.](#)

[Provisor Pty Ltd](#)

[Queensland Wine Industry Association](#)

[South Australian Research and Development Institute \(SARDI\)](#)

[South Australian Wine Industry Association Inc.](#)

[State Departments of Agriculture](#)

[State Government of South Australia](#)

[The University of Adelaide](#)

[Victorian Wine Industry Association Inc.](#)

[Wine Grape Growers Australia](#)

[Wine Industry Association of Western Australia Inc.](#)

[Wine Industry Suppliers Australia](#)

[Wine Industry Tasmania Inc.](#)

[Winemakers' Federation of Australia Inc.](#)

Staff

Office of the Managing Director

Isak Stephanus Pretorius, BSc (Hons), MSc, PhD
Orange Free State, Managing Director

Daniel Luke Johnson, BSc (Hons), PhD *FlindersUni*,
MBA GAICD, General Manager
– Business Development

Raelene Joan Blair, CertAppMgt (Mkting) *AIM*,
GAICD, Communication Manager

Shiralee Joy Dodd, BA, LLB (Hons) *UAdel*, Executive
Officer (Maternity Leave from 27/10/2008)

Roxanne Portolesi, BSc (Hons) *UniWA*, PhD
FlindersUni, Executive Officer

Amy Rose Hill, Personal Assistant to the Managing
Director (commenced 17/06/2009)

Kathryn Sarah Beames,
AWITC Conference Manager

Susanne Judy Milnes, AWITC Conference
Secretariat (commenced 03/02/2009)

Corporate Services

Hans Engelbert Muhlack, BEc *UAdel*, CPA, Group
Manager – Corporate Services

Mark Raymond Braybrook, Operations Manager

Jeffrey Mark Eglinton, BSc (Hons) *UAdel*,
IT Manager

Linda Joy Halse, BA, PostGradDip (Ind Rel)
UniNatal, HR Manager

Catherine Louise Borneman, BBus (Acc) *RMIT*,
CA, Accountant (Maternity Leave from 29/08/2008
to 04/01/2009)

Andrew George Cregan, BSc *ANU*, Dip (OH&S)
CIT, OH&S Coordinator

Susan Louise Rock, Help Desk Officer

Michelle Tania Carter, BCom (Acc) *UAdel*,
HR Administrator

Pauline Jorgensen, Cert IV (Bus Admin) *TAFE SA*,
Administration Support Officer

Rhonda Irene Milde, Finance Officer

Janice Margaret O'Donnell, Receptionist

Deborah Joy Thornton-Wakeford, Receptionist

Jeanette Fay Tooley, Administration Support

Research

Markus Johannes Herderich, staatlich geprüfter
Lebensmittelchemiker (CertFoodChem), PhD
UniWürzburg, Group Manager - Research

Paul Joseph Chambers, BSc (Hons), PhD
UniHertfordshire, Research Manager - Biosciences

Ian Leigh Francis, BSc (Hons) *Monash*, PhD *UAdel*,
Research Manager – Sensory

Yoji Hayasaka, Dip Eng (Ind Chem) *Tokyo IT*,
MPharmSc *MonashUni*, PhD *YamanashiUni*,
Manager – Mass Spectrometry Facility

Paul Anthony Henschke, BSc (Hons), PhD *UAdel*,
Principal Research Scientist – Microbiology

Mark Aiden Sefton, BSc (Hons), PhD *UniWA*,
Principal Research Scientist – Chemistry (con-
cluded 18/07/2008)

James Austin Kennedy, BSc, PhD *UniCalDavis* –
Research Manager – Chemistry (commenced
23/03/2009)

Elizabeth Joy Waters, BSc, PhD *UAdel*, Research
Manager – Biochemistry

Eveline Jutta Bartowsky, BSc (Hons), PhD *UAdel*,
Senior Research Scientist - Microbiology

Anthony Richard Borneman, BSc (Hons), PhD
UMelb, Senior Research Scientist - Biosciences

Christopher Daniel Curtin, BSc (Hons), PhD
FlindersUni, Senior Research Scientist – Biosciences

Robert George Dambergs, BSc (Hons) *UAdel*,
PhD *UniQLD*, Senior Research Scientist

David William Jeffery, BTech (Forens&Analyt
Chem), BSc (Hons), PhD *FlindersUni*, Senior Research
Scientist – Chemistry

Keren Bindon, BSc (Hons) *UniKwa-Zulu Natal*, MSc
UniStellenbosch, PhD *UAdelaide*, Research Scientist
(commenced 15/09/2008)

Peter James Costello, BSc (Hons), MSc *UniNSW*,
PhD *UAdel*, Research Scientist

Gordon Elsey, BSc (Hons), PhD *FlindersUni*, Research
Scientist (concluded 16/07/2008)

Richard Gawel, DipEd, BSc, GradDip (Oen) *UAdel*,
Research Scientist

Helen Elizabeth Holt, BAgSc (Hons), PhD
LaTrobeUni, Research Scientist

Simon Anthony Schmidt, BSc (Hons), PhD
FlindersUni, Research Scientist

Maurizio Ugliano, BSc (Hons) *UniNaples*, PhD
UniFoggia, Research Scientist

Cristian Andres Varela, BSc (Biochem), MSc
(Biochem), PhD *CatholicUniChile*, Research Scientist

Antonio Felipe Garcia Cordente, BSc(Chem),
BSc(Biochem), PhD *UniBarcelona*, Post Doctoral
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Matteo Marangon, PhD *UPadua*, Post Doctoral
Research Fellow

Dariusz Roman Kutyna, MSc *AgUniPoland*, PhD
VicUni, Casual Post Doctoral Research Fellow

Dimitra Liacopoulos Capone, AssDip (Chem),
BAppSc *UniSA*, Senior Scientist

Kenneth Frank Pocock, BAppSc *UAdel*, GradDip
(AppSc) *UniSA*, Senior Scientist

Tracey Ellen Siebert, ScTechCert (Chem) *SAIT*, BSc
UAdel, Senior Scientist

Jennifer Rose Bellon, BSc *UAdel*, Scientist

Patrick August-Giesecke Dimanin, Cert (Enol &
Vitic) *MichStateUni*, BSc (Vitic) *UAdel*, Scientist

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MSc *SilesianUniTech*, Scientist

Tangerine Parker, BSc *FlindersUni*, Scientist
(Maternity Leave to 31/08/2009)

Stella Kassara, BSc (Hons) *UAdel*, Scientist

Patricia Chaves Osidacz, BSc *StateUniCampinas*,
MSc *Unillinois*, Sensory Scientist

Brooke Travis, BAgSc (Oen) *UAdel*, Sensory Scientist

Wanphen Jitjaroen, PhD *UniBonn*, Visiting Scientist
(commenced 02/03/2009)

Gayle Ann Baldock, BSc (Hons) *UniGuelph*,
Technical Officer

Belinda Ruth Bramley, ScTechCert (Biol) *SAIT*,
Technical Officer

Angus Henderson Forgan, BSc (Hons) *FlindersUni*,
Technical Officer

Robyn Louise Kievit, BSc *UniSA*, BSc (Hons) *UAdel*,
Technical Officer

Jane Melissa McCarthy, Cert (Anim Hand), Cert
(Vet Nurs) *TAFE SA*, AdvCert (Med Lab Sc) *UniSA*,
Technical Officer

Kevin Herbert Pardon, AssDip (App Chem) *SAIT*,
Technical Officer



Staff

Mark Roger Solomon, BSc (Hons), BSc *FlindersUni*, Technical Officer

Katryna Agatha Van Leeuwen, BSc (Hons) *FlindersUni*, Technical Officer

Radka Kolouchova, AssDip *TechCollFoodTech*, Technical Officer

Caroline Elisabeth Abrahamse, BSc (Hons) *UAdel*, Laboratory Technician

Heather Margaret Donnell, Administrator

Samuel David Stranks, BA, BSc (Hons) *UAdel*, Casual (concluded 26/09/2008)

June Robinson, Research Laboratory Support

Microbial Metabolomics Facility

Meagan Diane Mercurio, BSc (Hons), BTech (Foren & Anal Chem) *FlindersUni*, Coordinator – Microbial Metabolomics Facility

Jeremy Crispin Hack, Technical Officer

Irina Rusinova, BSysEng(Hons) *MoscowEngPhysInst*, Technical Officer (concluded 12/02/2009)

Casual Sensory Panel

Lynn Alabaster (concluded 25/06/2009), Peter Charles Baldwinson, Barbara Jane Binns (concluded 25/06/2009), Jennifer De Livera, Kathrin Dressler, Andrea Louise Gamble (concluded 24/07/2008), Russell Bond Gardiner, Helene Jutta Herges (commenced 29/07/2008, concluded 25/06/2009), Gurinder Singh Khera (concluded 25/06/2009), Karin Laila Marie Nagle, Jennifer Kay O'Mahony, Samantha Parletta, Lindy Taeuber, Kathryn Jean Tse (concluded 25/06/2009), Christopher Howard Waters

Students

Eric Dennis, BSc (Hons) *FlindersUni*, PhD Student (concluded 01/04/2009)

Joanne Giaccio, BTech (Foren & Anal Chem), BSc (Hons) *FlindersUni*, PhD Student

Josh Hixson, BTech (Foren & Anal Chem), BSc (Hons) *FlindersUni*, PhD Student

Ellena Sophia Anne King, BAgSc (Oen) *UAdel*, PhD Student

Natoiya Dee Rayette Lloyd, BSc (Hons) *FlindersUni*, PhD Student

Simon Nordestgaard, BE (Chem) (Hons) *UAdel*, PhD Student

Tina Thi My Tien Tran, BSc (Microbiol/Biotech), BSc (App Biol) (Hons) *VicUni*, PhD Student

Steven Van Sluyter, BA, BSc *UniNthCarolina-Wilmington*, PhD Student

Nicholas Ian Warnock, BBiotech (Hons) *FlindersUni*, PhD Student

Gal Winter, BSc, MSc *HebUniJerusalem*, PhD Student

Bruno Fedrizzi, BSc, MSc *UniPadova*, Visiting PhD Student (concluded 01/05/2009)

Rocio Gomez-Pastor, BBioChem (Mol Biol & Gen) *InstAgFoodTech*, Visiting PhD Student (commenced 01/05/2009)

Etjen Bizaj, BSc *Uniljubljana*, Visiting PhD Student (commenced 02/02/2009)

Marco Lucchetta, TechDeg (Wine, Ag & Oen) *GBCerInst*, BScTech (Vit & Oen), MScTech *UniPadova*, Erasmus Fellowship (commenced 12/01/2009, concluded 10/07/2009)

Sara Landolfo, MAgScTech *UniPoliDelMar* (commenced 23/02/2009, concluded 31/07/2009)

Industry Development and Support

Con Arthur Simos, BAppSc (Oen) *UAdel*, Group Manager – Industry Development and Support

Peter Ronald Dry, BAgSc, MAgSc, PhD *UAdel*, Viticulture Consultant (commenced 26/10/2008)

Sally Jean Bell, BSc, PhD *UniWA*, GradDip (Wine Bus) *UAdel*, Senior Viticulturist

Linda Maree Bevin, BBus (Info Mgt), GradDip (Lib & Info Stud) *QUT*, Information and Knowledge Manager (Maternity Leave to 19/04/2009)

Adrian Dermott Coulter, BSc *FlindersUni*, GradDip (Oen) *UAdel*, Senior Oenologist

Leanne Michelle Curtin, BSc *FlindersUni*, Project Manager – Information & Knowledge Management (concluded 12/12/2008)

Creina Standish Stockley, BSc (Hons) *UAdel*, MSc *FlindersUni*, MBA *UniSA*, Health and Regulatory Information Manager

Sarah Louise Ballantine, BSc (Hons) *UAdel*, Project Officer

Sean Mathew Boden, BA *UAdel*, GradDip (Info Stud) *UniSA*, Systems Librarian

Geoffrey David Cowey, BAppSc (Wine Sc) *CSU*, BSc (Hons) *UAdel*, Oenologist

Matthew Grant Holdstock, BSc *FlindersUni*, GradDip (Oen) *UAdel*, Oenologist

Marcel Essling, BBus *VicUni*, BSc *UAdel*, Technical Officer

Emma Louise Kennedy, BSc *FlindersUni*, Technical Officer

Ingrid Betty-Maud Barratt, Dip (Lib & Info Stud) *TAFE SA*, Library Technician (Maternity Leave from 29/08/2008)

Anne Dorothy Lord, GradDip (Info Stud) *UniSA*, Library Technician (commenced 01/09/2008)

Virginia Frances Phillips, Administrator

Claire St George, Library Assistant

Fiona Mary Taylor, Library Assistant

Industry Applications

Peter William Godden, BAppSc (Wine Sc) *UAdel*, Group Manager – Industry Applications

Paul Alexander Smith, BSc (Hons), PhD *FlindersUni*, Research Manager – Industry Applications

Daniel Cozzolino, AgricEng *UniUruguay*, PhD *UniAberdeen*, Senior Research Scientist

Wieslawa Cynkar, BSc, PhD *UniWroclaw*, Research Scientist

Richard Anthony Muhlack, BE (Chem) (Hons), PhD *UAdel*, Process/Environmental Engineer

Ella Margaret Clare Robinson, BA, BSc (Hons) *UAdel*, Project Manager

Nevil Kamlesh Shah, BSc, MSc *UniQLD*, Scientist

Commercial Services

Vincent Thomas O'Brien, BE (Chem) (Hons) *UAdel*, PhD *UniQLD*, Group Manager – Commercial Services

Leanne Michele Craddock, BSc *UAdel*, Quality Systems and Laboratory Manager

Randell Leith Taylor, BSc (Hons) *UAdel*, Laboratory Supervisor

Warren Keith Roget, BEng (Mech) (Hons) *UAdel*, Technical Manager (commenced 25/05/2009)

Simon Paul Odell, BBiotech (Hons) *FlindersUni*, GradDip (Oen), PhD *UAdel*, Project Officer

Oliver David Lovat, BTech (Foren & Anal Chem) *FlindersUni*, Project Officer



Highlights of the year

Oenone Jean Macintyre, BSc, BE (Chem) (Hons)
PhD *UAdel*, Project Officer

Teegan Jean Schurgott, BAg *UAdel*, Customer
Service and Marketing Manager

Jelena Jovanovic, Customer Service Officer

Alana Williams, CertII (Hosp Op) *TAFE SA*, CertIV
(Japanese Lang) *VLLC*, Customer Service Officer
(Maternity Leave from 13/04/2009)

Andrea Francis, Customer Service Officer
(commenced 08/09/2008)

David Rolfe Boehm, BSc *UAdel*, Scientist

Heather Mandy Brooks, BSc *UAdel*, Scientist

Slavko Matthew Bekavac, BAppSc (Chem & Chem
Proc Tech) *UniSA*, Senior Laboratory Technician

Yvonne Staeffler, DipMedSc (Pharm) *ProfMed-
Studium*, Laboratory Technician

Daniel Scott Tynan, DipAppSc (Chem Tech) *UniSA*,
Laboratory Technician

Pamela Stepancich, BTech (Foren & Anal Chem),
BlnnEnt (Sc & Tech) *FlindersUni*, Laboratory Technician

Timothy James Gordon Reilly, BSc (Hons)
FlindersUni, Laboratory Technician

Carlo Mark Congiusta, BSc (Hons) *FlindersUni*,
Casual Laboratory Technician

See Appendix 3 for details of all students supervised
by the AWRI staff

During the year, the AWRI moved into its new home as part of the Wine Innovation Cluster, and the impact on our activities during this time was successfully managed for minimal disruption. The highlights from our activities during the year are below.

1 **The AWRI and two partners** developed and prepared for commercialisation an instrument for rapid non-destructive, in-bottle measurement of wine compositional variables.

2 **Crystal structure for a grape thaumatin-like protein solved.** This detailed information at the molecular level of wine protein structure will help us to better identify and target proteases and to identify those parts of the protein likely to interact with other wine components, such as phenolic compounds. Ultimately, this knowledge might lead to new technologies to control haze formation in white wine.

3 **State-of-the-art gene chip technology** and genome sequencing has been used to determine genetic differences across ten strains of the MLF bacterium *Oenococcus oeni*. This work has revealed that there is a very high level of genetic variation between strains, and novel genes have been identified that encode putative glycosyl hydrolases (enzymes that can shape the flavour of wine by releasing flavour compounds from inactive precursors). This work paves the way for the development of new, more robust strains that will enhance the sensory attributes of wine.

4 **Identification of the glutathione conjugate of 4-mercapto-4-methylpentan-2-one** (glut-4-MMP) in Sauvignon Blanc juice using HPLC-MS/MS and by comparison of data with a synthetic reference sample. This showed for the first time that there is a glutathione precursor to 4-MMP, which in all likelihood could also act as a precursor to the volatile 4-MMP found in wine. This finding will assist future studies aimed at identifying the role of glutathione precursors from grapes and determine the importance of them for thiol release into wine, especially in varieties that are low in cysteine precursors.

5 **Synthesis of glutathione precursors** to the varietal thiol 3-mercaptohexan-1-ol, along with their deuterated analogues, was completed. Ultimately, the successful synthesis of glutathione conjugates has allowed us to assign precursor stereochemistry, better understand their formation, and develop analytical methods for their quantitation in juice and wine.

6 **Two approaches have been developed to assess smoke taint** in grapes and wines. The first approach measures smoke intensity in a vineyard during a bushfire event and uses the smoke intensity data to assess the extent to which smoke has impacted on grape quality.

The second approach identifies guaiacol precursors in grapes using stable isotope techniques; as precursors are good candidates for markers to assess the degree of smoke-affect. It is hoped that a combination of the two new approaches, along with traditional approaches, will allow winemakers to better understand the likelihood of smoke taint in wine.

7 **Calibration models were developed** using a portable Bruker ATR-mid-infrared spectrophotometer, for ammonia, yeast assimilable nitrogen (YAN), total soluble solids and pH in juice and fermentation samples, the method requiring little sample preparation.

8 **Recent experimental data show that highest residual H₂S** in finished wine is associated with late onset of H₂S production. Conversely early onset and cessation of sulfide production led to little or no residual H₂S in wine.

9 **New, so-called, 'omics technologies** coupled with high powered computing and mathematical modeling take us into the arena of systems biology, which is poised to revolutionise wine research. The AWRI is fortunate to both house the South Australian node of Metabolomics Australia (formally launched this year) and have had a model wine yeast adopted by the Government-funded Bioplatforms Australia as a demonstration project to show how systems biology can be undertaken in Australia. This project will open up many opportunities for the development of greatly improved wine yeast strains.

10 **A closure trial study showed clearly that** the presence of even low level oxidation, TCA or reductive flavour can strongly influence consumers.

11 **From a study of different varieties and vintages** from various regions the vast majority (62%) of the wines that contained rotundone, were Shiraz. Perhaps not surprisingly, above-threshold levels of rotundone (>16 ng/L) were often encountered in wine originating from cool climate regions.

12 **Non destructive spectral scanning of bottles further validated as useful tool.** We used the Sauvignon Blanc bottling trial to demonstrate that it was indeed possible to collect bottle scans throughout the year-long trial period and then determine the free and total SO₂ levels of individual bottles retrospectively. This had not been previously demonstrated and was an extension and validation of the concepts we had described previously.



Highlights of the year

- 13 **Sensory studies investigated** such areas as: coinoculated and single strain yeast effects in white wine; the perseverance of yeast strain flavour differences over time; malolactic bacterial strain differences in red wine; the effect of closures and copper fining; the influence of nitrogen supplementation in the vineyard and in fermentation; phenolic related flavour effects on white wine; hydrogen sulfide aroma threshold in red and white wines; saltiness in red wine arising from sodium, potassium and chloride levels; and faults identified by wine show judges.
- 14 **The AWRI technical quality panel** has assessed 383 wines over the year for the incidence of off-flavours and taints, as well as technical assessment of individual wines for suspected faults.
- 15 **Results suggest that palate viscosity** in dry white wine cannot be enhanced by employing traditional winemaking approaches that elevate glycerol levels.
- 16 **Links between composition and perceived coarseness in white wines explored.** A sensory and compositional study on 24 commercial white wines showed that perceived astringency was related to the levels of residual sugar and titratable acidity as well as phenolic compounds, even in a sample set where all the wines had residual sugars less than 4 g/L. Furthermore, data from 200 consumers in Sydney indicated that a sizable proportion of consumers do not like wines with high perceived sourness and astringency, thus validating the need for research into this topic.
- 17 **Completion of the MCP tannin assay** and associated development of a database gives an overview of tannins in more than 3,000 Australian wines.
- 18 **Bottling and storage trial completed on Sauvignon Blanc.** This trial gives us additional information about the impact of closure choice on wine development and extends this to Sauvignon Blanc and the effect of copper fining.
- 19 **An historic landmark for the AWRI** has been the establishment of the first external node, based in Hobart at the Tasmanian Institute of Agricultural Research (TIAR). The primary function of this node is to collaborate with regional research programs and to foster targeted extension activities. This will form a model for possible future developments in other wine producing regions to support 'Regional Heroes'.
- 20 **Approval of a three year project and funding from Cancer Australia** for a project entitled *Resveratrol in the chemoprevention of colorectal neoplasia*.
- 21 **Research to Practice® training modules** updated with grapevine nutrition, pest and disease management and winegrape quality identified as key areas of interest to grapegrowers. Two training programs 'Managing grapevine nutrition in a changing environment' and 'Integrated Pest Management for changing viticultural environments' have been developed.
- 22 **The Advanced Wine Assessment Course** was held outside of Adelaide for the first time this year (Lilydale, Vic.). An abridged version of the course was also held in Dublin and London to key trade people in these markets. The 27th full course was also held this year and over 840 wine sector professionals have now undertaken the course.
- 23 **Support of Brand Australia through the finalisation of a partnership/joint venture agreement** between the AWRI and the Institute of Masters of Wine.
- 24 **The Industry Services team responded to more than 1,236 calls** for technical advice and information, 213 wine/health, technical and regulatory requests, and 320 viticulture enquiries.
- 25 **Twenty-one days of roadshow seminars and workshops were held** in 11 Australian wine-making zones and regions.
- 26 **A 27% increase in requests (4,800)** for information were managed by the Information Services team.
- 27 **Improved delivery of information** to stakeholders achieved through upgrade of content and format of the AWRI website.
- 28 **Nine webcasts of AWRI presentations** were recorded and made available on-line via the AWRI website.
- 29 **Eleven thousand copies of the AWRI annual publication *Agrochemicals registered for use in Australian viticulture 2008/2009*** were produced and the booklet was made available from the AWRI website and distributed with the Annual Technical Issue of *Australian and New Zealand Grapegrower and Winemaker*. Six agrochemical updates were prepared for industry email subscribers.
- 30 **Through increased commercial activity and a greater focus** on obtaining revenue from sources other than through the GWRDC, the AWRI achieved a year of record revenue. This has enabled the provision of increased resources and services to priorities of Australian grapegrowers and winemakers.
- 31 **The Constitution of the AWRI** was updated to bring it in line with modern corporate governance, and the results were communicated to key stakeholders.
- 32 **The AWRI's RD&E plan** was amended to allow an even greater focus on issues of relevance to Australian grape and wine producers, including sustainability and regionality.
- 33 **AWRI staff members gave** 244 oral presentations, conducted 8 workshops and presented 10 posters.
- 34 **AWRI staff members presented** 36 lectures and coordinated the Grape Industry Practices, Policy and Communication six week subject to undergraduate students.
- 35 **AWRI staff members** supervised/co-supervised 17 postgraduate students.
- 36 **AWRI staff members** responded to 6,663 recorded requests for information during the 2008/2009 year, or to put the statistics into perspective, 27 people contacted the AWRI seeking information on every working day of the year (a 13% increase over last year, on top of a 14% increase over the previous year). This figure does not include the amount of problem samples investigated (1,042) or the number of Commercial Services analyses undertaken during 2008/2009.

Readers are strongly encouraged to read the report in detail rather than relying on the brief details above for information.



Staff activities

Information on seminars, workshops, talks and poster papers given to outside organisations, academic lectures delivered, graduate students supervised, and the papers published is tabulated and can be found in Appendices 1–5 of the Annual Report. Activities in addition to those in the Appendices are described below.

Sakkie Pretorius is a member of the South Australian Wine Industry Council; the Wine Innovation Cluster Leadership Group; the Wine Industry Technical Advisory Committee (WFA); the AWBC's Compliance Advisory Committee; the Council of the Royal Agricultural and Horticultural Society of SA Inc.; the Wine Committee of the Royal Agricultural and Horticultural Society of SA Inc.; Editorial Board of the following journals: *American Journal of Enology and Viticulture*, *Annals of Microbiology*, *FEMS Yeast Research* and *Yeast*. He is the Chairman of the Australian Wine Industry Technical Conference Inc.; Conference Planning Committee of the Fourteenth Australian Wine Industry Technical Conference and of the National Wine Research Network (NWRN). He is a member of the International Commission of Yeasts, the Scientific Board of L'Institut des Sciences de la Vigne et du Vin (ISVV), Bordeaux, France, and the Scientific Committee of Institut Català de Recerca en Enologia i Viticultura (ICREV) Tarragona, Spain. He is also a Professor Extraordinary of the University of Stellenbosch and an Affiliate Professor of The University of Adelaide.

Dan Johnson is a Director and the Treasurer of the Australian Wine Industry Technical Conference Inc. and a participant in the 2009 Australian Wine Industry Future Leader's Program.

Markus Herderich is a Director of the Australian Wine Industry Technical Conference Inc., member of the Metabolomics Australia Executive Management Group, Industry Collaborative Innovation Program Consortium Committee and Wine Innovation Cluster Research Group. He is also an Affiliate Associate Professor of The University of Adelaide and a member of the Advisory Board of the *Journal of Agricultural and Food Chemistry*.

Eveline Bartowsky serves on the Joint Editorial Board of the *Journal of Applied Microbiology* and *Letters in Applied Microbiology* and serves on the Editorial Review Board of the *Journal International des Sciences de la Vigne et du Vin*. She is a member of The Waite Campus Health and Safety Forum, a member of the organising committee of the 11th International Symposium on the Genetics of Industrial Microorganisms (Melbourne, 2010), Poster Coordinator for the 14th Australian Wine Industry Technical Conference (2010 in Adelaide), and is an Affiliate Lecturer at The University of Adelaide.

Paul Chambers is a member of the organising committee for the 11th International Symposium on the Genetics of Industrial Microorganisms (Sydney in 2010), is coordinator of a national, Bioplatforms Australia/AWRI Wine Yeast Systems Biology project, and is coordinator of the Australasian Yeast Group (through its homepage at <http://www.ayeastgroup.org/>).

Daniel Cozzolino is a member of the honorary editorial board of the *International Journal of Wine Research*.

Bob Damberg is a member of the Wine Industry Tasmania Technical Committee and the National Wine Research Network (NWRN).

Leigh Francis is an Associate Editor of the *Australian Journal of Grape and Wine Research*, a member of the Editorial Board of the *Journal of the Science of Food and Agriculture*, and is also an Affiliate Lecturer at The University of Adelaide.

Jeremy Hack is a member of the Metabolomics Australia Analytical, Laboratory Information Management System (LIMS) and Informatics working groups.

Paul Henschke serves as an Associate Editor of the *Australian Journal of Grape and Wine Research*, is a member of the Editorial Review Boards of *Food Microbiology* and *Mitteilungen Klosterneuburg*, and is a member of the local organising committee for the Australasian Yeast Group Symposium to be held in Adelaide in December 2009. He is a guest lecturer at The University of Adelaide and Flinders University.

James Kennedy is an Associate Editor of the *American Journal of Enology and Viticulture*, and a Contributing Editor for *Practical Winery and Vineyard*. He is an Affiliate Associate Professor at the University of Adelaide, and is also a Courtesy Associate Professor at Oregon State University.

Meagan Mercurio is a member of the Metabolomics Australia analytical working group.

Simon Schmidt is a member and the ASBMB liaison officer on the Adelaide Protein Group (APG) organizing committee.

Elizabeth Waters is an Associate Editor for the *Journal of Agricultural and Food Chemistry*, an Affiliate Associate Professor, The University of Adelaide and an Adjunct Professor, National Grape and Wine Industry Centre, Charles Sturt University. She is a Director of Provisor Pty Ltd, a member of the Scientific Committee for Macrowine2010 (Turino, Italy, June 2010) and In Vino Analytica Scientia (Angers, France, July 2009), an Academic member of OzinWines™, a member of the International Scientific Committee of the *Journal International des Sciences de la Vigne et du Vin* and an Expert member of Performance BIB.

Peter Godden is a member of the 14th Australian Wine Industry Technical Conference Planning Committee and the Program sub-committee, and is Vice President of the Australian Society of Viticulture and Oenology.

Peter Dry is an Adjunct Associate Professor, University of Adelaide, a member of the Phylloxera and Grape Industry Board of SA and Associate Editor of the *Australian Journal of Grape and Wine Research* and the *Australian and New Zealand Wine Industry Journal*.

Creina Stockley is an Affiliate Senior Lecturer, School of Agriculture and Wine, The University of Adelaide and is the Coordinator of the Wine Science Course entitled *Grape Industry Practice, Policy and Communication*. She is a member of the National Drug and Alcohol Research Centre's Young People and Alcohol Project Advisory Group on behalf of the Winemakers' Federation of Australia (WFA), and the WFA Wine Industry Technical Advisory Committee, WFA Wine industry National Environment Committee and the WFA Wine and Social Responsibility Committee. She is also the DAFF nominated Australian delegate for Organisation International de la Vigne et du Vin (OIV) Health and Safety Commission (IV), and is currently the President of the Food Safety Expert Group. She is also a member of the honorary editorial board of the *International Journal of Wine Research* (Dove Medical Press), and of the Scientific Committee for the 2010 International Wine and Health Conference to be held in Italy.

Vince O'Brien is an Adjunct lecturer at The University of Adelaide and member of the following committees: 14th Australian Wine Industry Technical Conference Planning Committee, Winery Engineering Association Conference Planning Committee, Nomacorc Advisory Committee and Wine Industry Suppliers Association Innovation Committee.

Leanne Craddock is a member of the IWAG (Inter Winery Analysis Group) committee.

Roxanne Portolesi is a member of the AusBiotech Committee (SA Branch).

Acknowledgements

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Photography by Jacqui Way Photography



Team reports

Theme 1 Grape and wine composition

Improving microbial performance, wine diversity and wine quality

Staff and students

Caroline Abrahamse, Dr Eveline Bartowsky, Jenny Bellon, Dr Anthony Borneman, Dr Paul Chambers, Dr Antonio Cordente, Dr Peter Costello, Dr Chris Curtin, Angus Forgan, Jeremy Hack, Dr Paul Henschke, Robyn Kievit, Ellie King (PhD student, University of Adelaide), Radka Kolouchova, Dr Dariusz Kutyna, Jane McCarthy, Meagan Mercurio, Dr Simon Schmidt, Tina Tran, Dr Maurizio Ugliano, Dr Cristian Varela, Gal Winter (PhD student, University of Western Sydney)

Visiting scientists and students

Alice Betteridge (Honours student, University of South Australia), Etjen Bizaj (PhD student, University of Ljubljana, Slovenia), Bruno Fedrizzi (University of Padova, Italy), Sylvester Holt (MSc student, University of Copenhagen, Denmark), Rebecca Kilday (Honours student, University of Adelaide), Geoffrey Langhans (Honours student, University of Adelaide), Sara Landolfo (PhD student, Università Politecnica delle Marche, Ancona, Italy), Rocio Gomez Pastor (PhD student, Institute of Agrochemistry and Food Technology, Valencia, Spain), Nick Warnock (PhD student, Flinders University)

Collaborators

AB Mauri, Australia (Dr Anthony Heinrich); Australian Genome Research Facility (Professor Sue Forrest, Dr Annette McGrath); Australian Proteome Analysis Facility (Professor Mark Baker, Dr Alamgir Khan); Bioplatforms Australia (Andrew Gilbert); Flinders University (Dr Peter Anderson); Harvard University, USA (Dr Barbara Dunn); IASMA, Italy (Dr Giuseppe Versini); Laffort Australia (Dr Paul Boyer, Dr Tertius van der Westhuizen); Lallemend (Dr Ann Julien-Ortiz, Dr Sibylle Krieger-Weber, Dr Andrew Markides); Melbourne University (Professor Tony Bacic, Dr Ute Roessner); Murdoch University, WA (Professor Matthew Bellgard); Pontificia Universidad Catolica De Chile (Prof Eduardo Agosin); Universitat Rovira i Virgili (Professor Albert Mas); University of Adelaide (Professor David Adelson, Dr Paul Grbin, Dr Vladimir Jiranek); University of New South Wales (Professor Graham Fleet, Simone Li, Professor Marc Wilkins); University of Padova, Italy (Professor Franco Magno); University of Queensland (Professor Lars Keld-Nielsen, Dr Jens Kroemer); University of South Australia (Sylvie Callegari, Dr Miguel de Barros Lopes); University of Toronto, Canada (Professor Charles Boone); University of Western Sydney (Dr Vince Higgins); Victoria University, Melbourne (A/Professor Grant Stanley); Yale University, USA (Professor Michael Snyder); The Yalumba Wine Company (Simon Dillon, Louisa Rose)

The focus of Bioscience research at the AWRI is the improvement of microbial performance in wine fermentations, wine diversity and wine quality. Research in this broad arena encompasses physiology, genetics, molecular biology, biochemistry and systems biology of wine yeast and bacteria. The aims include: identifying and generating novel yeasts with improved winemaking and sensory-imparting properties; optimising fermentation outcomes by developing improved yeast nutrient supplementation regimes; improving robustness of wine yeasts and malolactic bacteria; utilising malolactic fermentation (MLF) to enhance wine quality; and developing 'low-alcohol' yeasts. The following is an overview of some of the activities of the Biosciences team and potential new beneficial applications in wine production practices.

Flavour-active yeast: harnessing yeast to modulate wine flavour

Staff and students

Dr Chris Curtin, Robyn Kievit, Dr Antonio Cordente, Ellie King, Gal Winter

The flavour-active yeast research program is focused on understanding how the metabolism of wine yeast interacts with grape juice in the wine production environment, and ultimately how this impacts on wine sensory properties. Practical outcomes from this work provide winemakers with tools to modulate aroma and flavour, recent examples being; novel yeast strains that produce less hydrogen sulfide during fermentation, and yeast blends that modulate the balance of esters and volatile thiols in Sauvignon Blanc.

Recent work continues to investigate the role of yeast in modulating Sauvignon Blanc aroma. In collaboration with Dr Vincent Higgins (University of Western Sydney), we have studied the transcriptome of wine yeast in a system where differential volatile thiol accumulation is observed in response to rehydration and fermentation nutrients. In another collaborative project with Dr Peter Anderson's laboratory (Flinders University) we have expressed and purified candidate yeast genes involved in release of the volatile thiols 4-mercapto-4-methylpentan-2-one (4MMP) and 3-mercaptohexan-1-ol (3MH).

We are also revisiting Australia's most widely grown white variety, Chardonnay. Here the preliminary goal has been to understand the diversity of sensory profiles achievable through judicious choice of yeast, and whether these differences were sufficient for consumer preference to be affected. A Margaret River Chardonnay juice was fermented with nine different active dry wine yeast products, including some commonly used in Chardonnay production. The resultant wines were profiled in collaboration with the AWRI Sensory Team. Significant differences were noted in acetate ester

related attributes such as 'solvent' and the volatile thiol attribute 'cat pee/sweaty', along with several other descriptors including 'tropical', 'yeasty', 'sweetness' and 'overall fruit flavour'. All wines were within appropriate specifications (i.e. all contained <2 g/L residual sugar) and there were no significant differences between fermentation replicates.

Consumer preferences for seven of these wines were assessed in the AWRI's new sensory facilities nine months after they were bottled. Significant differences in preference were noted for a segment (n=33) of 101 consumers, meaning these consumers were able to discern differences between the samples in characteristics that influence their 'liking' of the wines. The most preferred wine for this segment was rated highest in 'overall fruit flavour', 'viscosity', and 'sweetness' by the AWRI's trained sensory panel. This wine was made using a blended yeast product incorporating non-*Saccharomyces* yeast species, in a sense simulating a 'wild fermentation'.

Further work will focus upon development of new co-inoculation options to further expand the sensory space of Chardonnay through choices made prior to fermentation.

Fermentation nutrient effects on red wine volatile composition

Staff and students

Dr Paul Henschke, Dr Maurizio Ugliano, Radka Kolouchova, Gal Winter

Recent investigations into how nitrogen supplementation of low nitrogen grape juices or musts can alter the production of volatile compounds by yeast was summarised in the AWRI's previous Annual Report. Changes in the chemical composition of wine can be expected to affect its sensory profile, and indeed work in progress is suggesting that both the flavour profile and style of wine can be modified by nutrient modifications of the juice or must. Recent winemaking studies have focused on the production of volatile sulfur compounds by yeast and how their formation is influenced by the nitrogen content of the juice or must.

Of the volatile sulfur compounds produced by yeast, hydrogen sulfide (H₂S) continues to be a perennial problem due to its association with off-flavours, often described as 'reductive' or 'rotten egg', that are strongly detrimental to wine quality. H₂S is principally formed during alcoholic fermentation, being most commonly observed during the early stages, less often during the late stages and sometimes throughout fermentation (Figure 1). Because the causes of H₂S evolution cannot be easily determined in a winery setting, its prediction or diagnosis is particularly difficult to achieve. Various practical options for helping winemakers diagnose and manage H₂S production have recently



been discussed by Ugliano et al. (*Aust. N.Z. Grape-grower Winemaker 37th Annual Technical Issue* [545a], 30, 32, 34, 36-38; 2009).

Low availability of must fermentation nutrients is an important cause of H_2S production, especially in wine regions in which the content of these nutrients in musts is consistently low. Depletion of yeast assimilable nitrogen (YAN) is associated with H_2S formation, particularly during the early stages of fermentation when yeast growth is active (Figure 1; early-mid phase or growth associated H_2S). This cause can usually be ameliorated by the addition of DAP or proprietary fermentation nutrient preparations that contain inorganic or organic nitrogen (Figure 1).

Yeast strains that produce noticeable H_2S in low YAN juices and musts respond to DAP supplementation in a yeast strain-dependent and must/juice-dependent manner. That is, some strains in some musts/juices respond by producing less H_2S while other strains show little response, however these same strains can show very different responses in other musts. For example, with some DAP-responsive strains, DAP supplementation of the must delays onset of H_2S production and total H_2S produced, as exemplified by strain A in Figure 2. However, not all yeast strains respond to DAP supplementation as for strain A. For example, strain B produces similar total amounts of H_2S throughout fermentation, irrespective of the amount of DAP added to the must at the start of fermentation. In this case, DAP addition not only delays the onset of H_2S formation, but it can also prolong its formation and, at certain DAP levels, it results in increased H_2S production. The biochemical mechanism determining an increase in H_2S following DAP supplementation is unclear. However, in this case, subsequent DAP additions have been observed to lower H_2S production. These examples serve to illustrate that different patterns of H_2S production can result from DAP supplementation. At this time it is not yet possible to predict which combination of yeast strain and grape must will lead to wines containing residual H_2S . Several laboratory-based screening methods have been proposed, such as performing fermentation trials prior to harvest.

The most critical stage of H_2S production is that which typically occurs late in fermentation when less than 50–100 g/L of sugar remains and yeast growth has ceased (Figure 1; late phase or non-growth phase associated H_2S). Some yeast strains appear to be more susceptible than others. Although YAN is generally undetectable in the later stage of fermentation, H_2S production at this stage is typically unresponsive to DAP addition. Some ferments respond to aeration (pump-over, rack and return) or vitamin supplements, although H_2S production might simply be lowered and not eliminated. It is believed that yeast are mobilising S-reserve compounds as sources of nitrogen for cell maintenance activities. Recovery of nitrogen from these reserves leads to the release of H_2S .

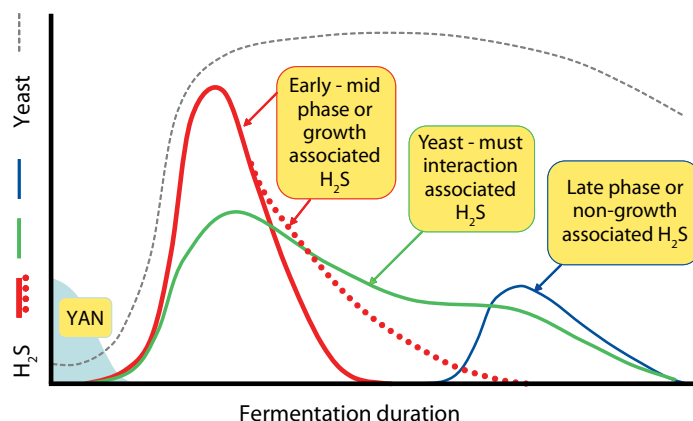


Figure 1. H_2S production by yeast during fermentation in a low nutrient juice or must (This figure has been reproduced from Ugliano, M., Winter, G., Coulter, A.D., Henschke, P.A. Practical management of hydrogen sulfide during fermentation - an update. *Aust. N.Z. Grapegrower Winemaker 37th Annual Technical Issue* [545a], 30, 32, 34, 36-38; 2009)

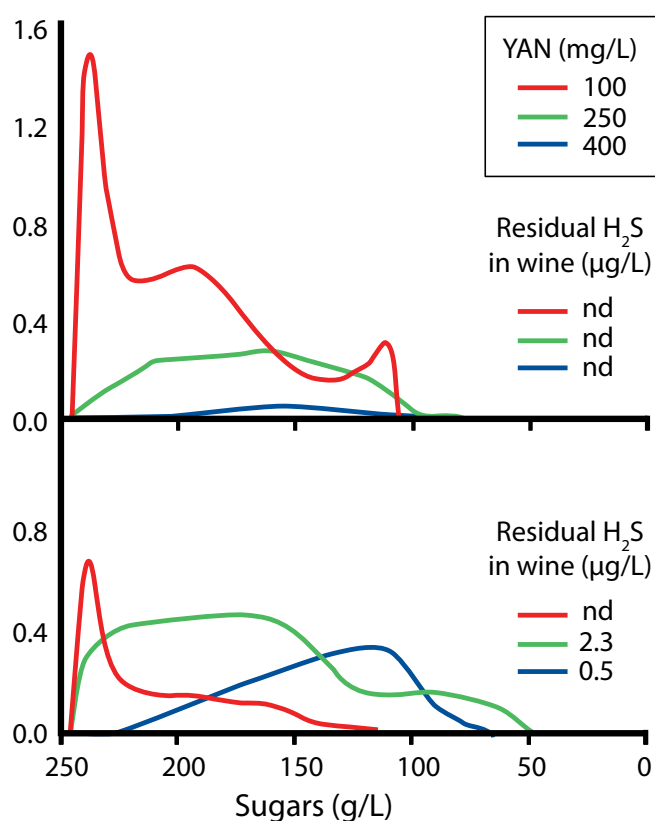


Figure 2. H_2S production by two yeast strains (A and B) in a low YAN (100 mg/L) grape must supplemented with DAP to give initial YANs of 250 mg/L and 400 mg/L. Both yeast strains A and B produced H_2S under all must nitrogen treatments tested; however, only wines from several of the treatments contained residual H_2S . For yeast A, when the must was supplemented with DAP (0.75 g/L or 15 g/L must), the onset of H_2S production was delayed and amount produced was less than the unsupplemented control must. H_2S production ceased by the mid-point of fermentation for all treatments and no H_2S was detected in the wines after wine clarification. On the other hand, yeast B produced similar amounts of H_2S whether or not DAP had been added. However, DAP supplementation prolonged H_2S production into the late stages of fermentation, such that those finished wines contained significant residual H_2S (adapted from Ugliano et al. *J. Agric. Food Chem.* 57, 4948–4955, 2009 and Ugliano et al. *Aust. N.Z. Grapegrower Winemaker 37th Annual Technical Issue* [545a], 30, 32, 34, 36-38; 2009).
nd, not detectable



Team reports

Our recent research has strongly implicated the timing of H_2S production during fermentation to be a highly important factor in determining the occurrence of residual H_2S in finished wine (AWRI publication #1121; Figure 2). This work, which was undertaken with a low YAN Shiraz must, showed that if H_2S production ceased before approximately the mid-point of fermentation then no H_2S could be detected in the wines after fermentation. However, in cases when the yeast continued to produce H_2S beyond the mid-point of fermentation then significant H_2S could be found in the wines. This work therefore suggests that H_2S produced after the vigorous stage of fermentation might be considerably more important for wine residual H_2S than that which forms early in fermentation. However, as with all laboratory-based investigations, this finding needs to be verified under winery conditions.

Predicting whether or not a juice or must will produce H_2S during fermentation is not yet possible, largely because multiple factors are involved, which can occur singularly or in combinations. However, some rapid methods are available to measure H_2S , which can be used to screen the ability of different juices and juice/yeast combinations to produce H_2S , as well as for the monitoring of H_2S formation during winery fermentations. These include selective H_2S detector tubes and the Nitro-Genius® kit (AWRI publication #1121, www.anchorwineyeast.com). The AWRI is currently working to optimise a rapid procedure to monitor H_2S formation in laboratory and winery fermentations.

The choice of yeast strain remains as one of the most important factors in limiting H_2S production during fermentation. High variability amongst yeast strains with respect to H_2S production has long been recognised. Various attempts have been made to breed yeast strains with commercially acceptable levels of H_2S production by selection and gene technologies. Recently, scientists at the AWRI developed non-genetically modified (non-GM), industrially useful strains (AWRI publication #1120), which are now available from Mauri Yeast Australia (AWRI publication #1018). Yeast strains, such as these, may become a tool of choice when limitation of H_2S production is necessary.

***Saccharomyces bayanus* wine yeast preparation available in active dried form**

The AWRI has an ongoing program of developing new and novel strains of fermentation yeast which provide the winemaker with greater flavour and style options. Updates on progress in the development of several isolates of *Saccharomyces bayanus* have been reported in previous Annual Reports. *S. bayanus* is characterised as a cryotolerant yeast when compared with the majority of yeast used in winemaking, which are mesophilic strains of *Saccharomyces cerevisiae*. In particular, *S. bayanus* grows and ferments at lower temperatures, produces more glycerol and succinic acid, but less acetic acid and produces a more complex aroma



Dimitra Capone and David Jeffery

profile (less estery and more savoury/cooked fruits) and greater mouth-feel. Novel *S. bayanus* strains are finding several applications but seem to be especially well suited to wines produced on yeast lees and aged in barrel. In wines made with early harvested fruit, this yeast is reported to soften the acidity and reduces the apparent 'green' characters, a valuable property that persists in aged wines.

Saccharomyces bayanus AWRI 1176 is now produced by Lallemend in the form of an active dried yeast preparation for use in winemaking. This strain behaves in a manner familiar to *S. cerevisiae* strains and therefore does not require any significant changes in winemaking practice except that being a high nitrogen requiring strain it responds well to good nutrient management practices. *S. bayanus* AWRI 1176 provides winemakers with greater options for modifying wine style and can give their wines a greater competitive advantage in a crowded market place.



Figure 3. Lallemend's active dried preparation of *Saccharomyces bayanus* AWRI 1176



Improving Australian sparkling wines and Pinot Noir

Staff

Dr Bob Dambergs

Collaborators and students

Clover Hill (Karina Dambergs); Croplands Ltd (Sean Mulvaney); Flextank International (Peter Steer); Frogmore Creek (Nick Glaetzer); Janz (Natalie Fryar); Josef Chromy (Jeremy Dineen); Meadowbank Estate (Gerald Ellis); Moorilla (Conor van der Rees); Pooley Wines (Matt Pooley); Tamar Ridge (Dr Andrew Pirie, Dr Richard Smart); Tasmanian Institute of Agricultural Research (Dr Dugald Close, Dr Kathy Evans); Tolpuddle Vineyard (Geraldine Colombo); University of Tasmania (Dr Joanna Jones, Dr Tim Gale, PhD students: Reuben Wells, Fiona Kerslake, Linda Donnachie); Wine Industry Tasmania (Stuart Nettlefold); Winemaking Tasmania (Julian Alcorso)

The formation of the AWRI's Tasmanian node represents a landmark in the history of the AWRI. In November 2008, Dr Bob Dambergs relocated to Hobart and established an office of the AWRI within the Tasmanian Institute of Agricultural Research (TIAR), in the School of Agriculture at the University of Tasmania. The Node is funded through the Industry Cooperative Innovation Program by AusIndustry and performs a research and extension function as part of this collaborative project that aims to 'Improving Australian sparkling wines and Pinot Noir'. Although the AWRI has participated in many collaborative projects in the past, this is the first time this has been approached through an AWRI office and shared laboratory that is co-located with a regional partner.

Having established many direct local interactions will foster 'Regional Heroes' and new research opportunities in areas such as sparkling wine and Pinot Noir production. These activities are complementary to the AWRI's core program and facilitate technology transfer and innovation from existing work done at the AWRI. Already, new multivariate analysis methods developed at the AWRI have been applied to Tasmanian-based projects: for example, E-nose analysis of volatiles in wine made from Pinot viticultural trials; analysis of phenolic profiles of trial wines; and analysis of autolysis characters in commercial sparkling wines.

An important aspect of the initial research by the consortium is benchmarking to determine targets for Pinot Noir viticultural and winemaking trials. For example, Figure 4 shows that although Pinot Noir grapes tend to have relatively high tannin concentrations, the wines are at the lower end of the scale; this clearly underlines the importance of tannin extractability and management in Pinot Noir winemaking.

Defining and controlling important volatile compounds and their impact on wine aroma and flavour

Staff and students

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Collaborators

Adelaide Hills Vine Improvement Inc. (David Coleman); CSIRO (Dr Dean Lanyon); Curtin University of Technology (Associate Professor Mark Gibberd, Dr Ayalsew Zerihun); Flinders University (Associate Professor Michael Perkins); The Hardy Wine Company (Paul Carpenter); Lerida Estate (Jim Lumbers); Mt Majura Vineyard (Frank van de Loo); Nepenthe Wines (Stefan Chandler); Orlando Wines (Hylton McLean, Nick Bruer, Brian White, Angus Davidson); Petaluma Wines (Chris Morley); Shaw and Smith Winery (Darryl Catlin); Symrise (Dr Gerhard Krammer) University of Adelaide (Professor Dennis Taylor, Dr Mark Sefton, Dr Gordon Elsey); University of Auckland (Associate Professor Paul Kilmartin, Gerard Logan)

An understanding of the relationship between wine composition and wine aroma and flavour is essential to be able to influence and optimise grape and wine quality. These aromas and flavours include many important varietal and bottle-age characters, and characters associated with oak, wine microorganisms, and oxidation, as well as taints, 'off-flavours', 'reduced', and 'green' characters. Our objectives are to determine the chemical nature of hitherto unrecognised important volatile wine components; enhance our understanding of the relationship between wine composition and sensory properties; develop analytical methods for important wine components and their precursors; and determine the effect of viticultural and

oenological techniques and wine storage conditions on the formation and fate of these compounds.

Characterising key compounds responsible for the aroma and flavour in unique Australian wine styles remains a priority, with activity in a number of topical areas of research. Lead compounds are being identified, and measurement capability is being developed for varietal and fermentative aroma compounds which contribute to mint, spice, tropical and berry characters in Australian wines. We also aim to identify new compounds which impact on wine aroma. Methods for analysis of sulfur compounds and precursors are being investigated, including application of methods to determine the impact of a number of sulfur compounds on reductive characters or off-flavours in wine. The capacity to react quickly to assess taint and fault issues is continually being strengthened, with synthetic and analytical chemistry playing key roles in providing resolution of these unforeseen events.

Identification of a potential precursor to the varietal thiol 4-MMP

Volatile, sulfur-containing compounds are widely regarded as important contributors to the aroma and flavour of some wine varieties such as Sauvignon Blanc. More specifically, some polyfunctional thiols – those containing other functional groups such as alcohols, ketones and esters – are responsible for imparting desirable varietal characters at low concentrations. Such thiols include 4-mercapto-4-methylpentan-2-one (4-MMP; box-tree aroma) and 3-mercaptohexan-1-ol (3-MH; passion-fruit and citrus aromas) in wine, yet these compounds are bound to non-volatile precursors in grapes. Studies on cysteine conjugates have identified the fermentation process as necessary for the release of the volatile thiols into wine. However, the identity of absolute precursors in grapes and juice to such volatile thiols in wine, as well as the formation of the precursors in grapes and juice, is still open to speculation.

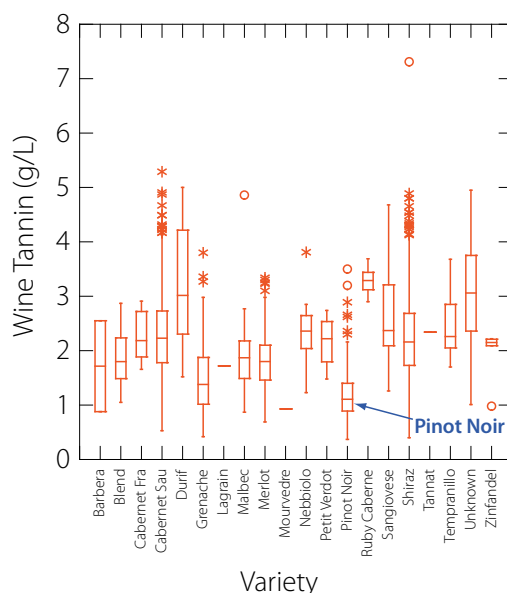


Figure 4. A survey of wine tannins by variety. Tannin was measured using the methyl cellulose precipitation (MCP) assay. The boxes represent the middle 50% of values, with the line within the box representing the median. The whiskers show the upper and lower quartiles and the individual points represent outliers



Team reports

Previous work by others over the past decade had identified glutathione and cysteine conjugates of 3-MH and the cysteine conjugate of 4-MMP. Adding to this, we recently identified the glutathione conjugate of 4-MMP (glut-4-MMP) in a Tasmanian Sauvignon Blanc juice. A juice sample was concentrated and purified using low-pressure C18 chromatography. Extensive analysis using HPLC-MS identified a peak which seemingly corresponded to glut-4-MMP. In-house synthetic capability allowed for synthesis of a pure reference sample of glut-4-MMP, which was extensively characterised to confirm the structure. Comparison of the HPLC-MS data showed conclusively that the compound isolated from the Sauvignon Blanc juice was the same as the synthesised material. This established for the first time presence of a glutathione conjugate of 4-MMP, which in all likelihood could also act as a conjugate of the volatile 4-MMP found in wine. This finding will assist future studies aimed at identifying the role of glutathione precursors within the grapevine and determining the importance of them for varietal thiol release into wine. We plan to follow up on a number of these interesting aspects, to enhance our knowledge of varietal thiols in wine, and provide tools for their manipulation.

Structural assignment of 3-MH glutathione precursors

Synthetic capability is a crucial aspect of understanding grape and wine flavour research and it has benefited us immensely over the years. Synthesis allows confirmation of the structures of newly found wine components, provides authentic standards for sensory and fermentation trials and affords a means of obtaining deuterated analogues for accurate quantitation. New synthetic strategies are also developed for difficult synthetic targets, enriching the synthetic methodology available to other fields of chemistry and providing enough authentic, well-defined material to undertake meaningful research.

Thiol precursors are a good example of the utility of synthesis, as they are key to an important area of research and essential for a range of studies, such as developing analytical methods, examining their fate during fermentation and aiding creation of new yeast strains. It is becoming increasingly evident that glutathione precursors might be at least as important as the relatively well-understood cysteine conjugates, with which many groups tend to work. We were recently involved with the synthesis of glutathione precursors to the varietal thiol 3-mercaptohexan-1-ol, along with their deuterated analogues. Ultimately, the successful synthesis of glutathione conjugates has allowed us to assign precursor stereochemistry, better understand their formation, and develop analytical methods for their quantitation in juice and wine. It has also given us the information required to correlate glutathione precursor structure with the corresponding enantiomers of the free thiol 3-MH, which have different sensory properties. Furthermore,

we have synthesised precursors for fermentation experiments to relate the type of precursor with the extent of thiol liberation in wine.

Australian wines and pepper character

Over the past few years, we have worked to identify the compound responsible for the pepper character found in some Australian Shiraz wines. Following this, we developed methods for the extraction and analysis of this sesquiterpene rotundone, in juice and wine. We have now started testing some of the theories first raised in the original reports for drivers of pepperiness, such as importance of grape variety, cultivar, clone type and region. For instance, it is known that rotundone levels vary between vineyards and between vintages within the same vineyard, but the causes of this are unresolved. The reason grapes contain this compound is also a mystery; often a plant might produce such compounds as a defense mechanism.

We are attempting to answer some of the questions involving rotundone in grapes and wine. As a starting point we undertook rotundone analyses of a large range of commercially available Australian wines (137 predominantly red wines obtained from local retailers) of different varieties and vintages from various regions. The range included Shiraz, Merlot, Durif, Pinot Noir, Cabernet Sauvignon and several other interesting wines from popular winegrowing regions from the early 1990s until 2006. The vast majority (81%) of the wines had no detectable rotundone (of the wines that contained rotundone, 62% were Shiraz). It was apparent from the data that above-threshold levels of rotundone (>16 ng/L) were often encountered in wines originating from cool climate regions, which is in agreement with previous observations. This survey helped to narrow our focus for planned grape studies, as we aimed to further our knowledge of viticultural drivers of pepper character. It also revealed the presence of this compound in varieties other than Shiraz, particularly Durif and Graciano wines.

In addition, an ongoing study investigates the effects of several closures on rotundone levels in bottled wine, to determine stability of the compound and whether it is 'scalped' by closures. An experimental Shiraz wine was spiked with rotundone and bottled under three different closures. The same wine was also sealed in ampoules, which served as controls for a number of time points. Over the relatively short time period since the study began (six months) there was no dramatic change in rotundone levels, and the three closures performed very similarly. The results for the closures are only slightly lower than the control sample (glass ampoule) where no scalping can take place. Other studies into the stability of rotundone under wine-like and accelerated ageing conditions showed no striking effects on its concentration. The stability of rotundone under wine-like conditions and the relative lack of scalping of the compound indicate that the pepper characteristics of a particular wine

at bottling are unlikely to change drastically over time with proper storage conditions.

Influences on white wine mouth-feel perception

The effect of the important wine matrix component glycerol on the perceived viscosity of dry white wines was first investigated. After masking the natural sweetness of glycerol using two novel methods – prior oral exposure to the anti-sweetness agent *Gymnema sylvestre*, and by equalising sweetness using a non-viscous high potency sweetener – the palate viscosity of dry white wine was found to be unaltered by increased glycerol levels. This result suggests that palate viscosity in dry white wine cannot be enhanced by employing traditional winemaking approaches that elevate glycerol levels. Increased levels of polysaccharides are thought to contribute positively to white wine texture. A multilayer countercurrent chromatography (MLCCC) system for purifying crude ethanolic extracts from white wine has been optimised and is currently being used to obtain gram quantities of white wine polysaccharides of sufficient purity for use in full-scale sensory trials.

Effect of manipulation of nitrogen application in the vineyard

The effects of nitrogen application on grape yeast assimilable nitrogen (YAN) and wine composition and sensory were examined for a third successive season. In addition, soil samples were collected just prior to budburst. Results showed that moderate to high levels of salt were present in the profile, which was not surprising considering the low winter rainfall. The Industry Applications group showed that soil components could be measured by near infrared spectroscopy (NIR) in the field, which is a useful outcome. Petiole and blade sampling was undertaken at flowering and veraison. The salt levels were high, which was expected given the results from the soil testing. Vineyard growth measures were undertaken at flowering and veraison. Nitrogen had little impact on any of the growth parameters at flowering. At veraison there was a linear correlation between nitrogen and leaf layer number and percentage of interior leaves. Nitrogen had no effect on shoot number or pruning weight, which was not surprising given the lack of effect on vine growth parameters during the growing season.

Veraison was one week later in comparison to the previous two seasons. Bunch sampling commenced at veraison and was undertaken on a weekly basis until harvest. We observed in this season, as was the case in many regions that berry sugar accumulation came to a standstill after the 'heat wave'. In addition, a large number of vines started showing significant signs of salt toxicity in the three week period prior to harvest and did not have a large enough functioning canopy to support an extended period of hang time. Nitrogen had no effect on yield or any of the yield components,



which included berry weight. Nutritional data for 2009 grapes and wines at the end of fermentation was obtained. In grapes, total nitrogen increased and phosphorus declined as the rate of nitrogen applied to vines increased. Nitrogen had no effect on grape sodium concentration but chloride concentrations were higher in those grapes from vines that received nitrogen in comparison to grapes from vines that received no nitrogen.

This same effect of elevated chloride carried over to the wine. Given the very high levels of chloride in the petioles at flowering and veraison it was not surprising that all experimental wines exceeded the legal limit of salt allowable in Australian wine, which is 1 g/L as sodium chloride. Some of the results from this trial have been incorporated into two Roadshow presentations, and were presented at the 8th International Symposium on Grapevine Physiology and Biochemistry and at the GIESCO Symposium in Davis, California.

Theme 2 Grape and wine production

Improving robustness of wine yeast to minimise the risk of sub-optimal fermentations

Staff and students

Dr Paul Chambers, Dr Simon Schmidt, Tina Tran

Sub-optimal, including stuck and sluggish, fermentations are a perennial problem for winemakers the world over. While some of the causes of these troublesome fermentations are known and can be addressed by winemakers, mostly they continue to be a major drain on resources, are very costly and may impact negatively on wine quality. Therefore, the development of yeast strains that are more robust in the face of 'difficult' grape juice or challenging fermentations conditions would be of enormous benefit to producers; such yeast would be less likely to be recalcitrant when the going gets tough.

Stress-tolerance in yeast is generally regarded as a reasonable indicator of robustness, and has been an area of interest for the yeast research community for many years. Much of the focus of this work has been to understand the genetic basis of stress tolerance. Laboratory strains of *Saccharomyces cerevisiae* have been the workhorse in much of this work and, as a result, many variants of laboratory strains have been identified with enhanced stress-tolerance attributes. Unfortunately these laboratory strains are inherently less stress-tolerant than their industrial relatives.

Researchers at the AWRI are currently evaluating the effect of previously identified stress tolerant genes from laboratory yeast strains on the ethanol tolerance and fermentation performance of wine yeast. The project utilises the wine yeast strain AWRI 1631, which was recently sequenced at the AWRI. The aim of this is to establish whether these previously identified genetic determinants of stress tolerance contribute to robustness in a wine yeast.

This work is being undertaken by two visiting PhD students: Sara Landolfo (Università Politecnica delle Marche, Italy) and Rocio Gomez Pastor (Institute of Agrochemistry and Food Technology, Valencia, Spain), under the supervision of staff at the AWRI. Preliminary results indicate that at least some genes that confer ethanol tolerance in laboratory strains of *S. cerevisiae* are also capable of increasing ethanol tolerance of wine yeast. This paves the way for the development of wine yeast strains with increased robustness, which will be less likely to produce sub-optimal fermentations.

Connecting *Oenococcus oeni* genetics to winemaking

Staff

Dr Eveline Bartowsky, Jane McCarthy, Dr Peter Costello, Caroline Abrahamse, Dr Anthony Borneman

The lactic acid bacterium *Oenococcus oeni* plays an essential role in grape vinification, lowering wine acidity and improving wine sensory characteristics through malolactic fermentation (MLF). Interestingly, even though the presence of microbes in wine was noted nearly 150 years ago by Louis Pasteur, it was not until the late 1960s that the bacterium associated with MLF was formally identified: originally as *Leuconostoc oenos*, then, 25 years later, as *O. oeni*. Over subsequent years, much research has been devoted to increasing our understanding of the metabolism of *O. oeni* and how this influences the overall sensory qualities of wine. However, there is still relatively little known about the genetics of this bacterium; for example we know nothing about how genetic variation between different strains of *O. oeni* impacts on wine relevant traits such as SO₂ and pH tolerance.

Until recently, genetics experiments were restricted to studying one or small numbers of genes. However, new technologies now permit us to examine all of the genes in an organism (known as the genome) in a single, genomics, experiment. Using, for example, genomic micro-array technology enables us to compare thousands of short stretches of genetic material (DNA), covering the entire genome of an organism, between a reference and other strains, thus providing an in depth view of genetic variation across strains (the technique used for this is known as comparative genome hybridisation or CGH). This approach has been used in research at

the AWRI to measure and map genetic diversity across ten isolates, commercial and natural, of *O. oeni*. Strain PSU-1, whose genome was recently fully sequenced, was used as the reference, and the other strains were chosen based on their phenotypic diversity. Numerous small differences (less than 1000 nucleotides in length) were identified across the ten strains, however, two distinct deletions of greater than 20,000 nucleotides in length were found (this represents more than 1% of the total *O. oeni* genome) in five of the *O. oeni* strains. The significance of this variation in a wine context is to be determined in future experiments.



Paul Chambers (L), Anthony Borneman (R)

One *O. oeni* strain (AWRI B429) was chosen for full genome sequencing (i.e. determining the nucleotide sequence of the genome), so that it could be compared with the PSU-1 genome, and a third, recently sequenced, French strain, BAA-1163. This enabled us to obtain greater insight into the nature of genetic differences in regions of the genome carrying the highest levels of variation, as identified in CGH experiments. There was no clear correlation between the loss of genomic material and the ability of these strains to undertake MLF or to proliferate in wine. Interestingly, strain AWRI B429 has numerous additional DNA sequences including two genes that encode glycosyl hydrolases. The presence of these additional enzymes might play a role, through the release of important glycosylated aroma compounds, in shaping different sensory characteristics attributed to MLF.

The outcomes of this research will lead to a much greater understanding of how *O. oeni* shapes wine sensory attributes and will enable winemakers to run efficient MLFs with targeted flavour and aroma outcomes to produce their ideal wine.



Team reports

High-throughput screening of novel wine yeast isolates to generate improved wine microorganisms

Staff

Dr Simon Schmidt, Dr Angus Forgan

Microbial strain development programs, by their very nature, generate large numbers of variants; only a small proportion of which are likely to be of value to producers. Increasing the number of variants that can be screened for desirable properties increases proportionally the chance that useful, novel strains will be found. However, traditional fermentation methods, because of the scale of operation, severely limit the number of variants that can be screened; and this is exacerbated by bottlenecks in analytical capacity.

Fermentation miniaturisation, coupled with analytical automation, has been a key step forward in addressing both spatial and capacity limitations for screening collections of microbes. Huge numbers of microbes can be screened in the same experiment by scaling down to a fermentation size of 0.2 mL (about 1000 x smaller than standard laboratory fermentations) whilst maintaining outcomes similar to larger-scale fermentations. In addition, small-scale ferments lend themselves well to automation of fermentation monitoring and phenotyping.

The recent acquisition of an integrated robotic workstation, comprising a liquid handling unit, incubator and spectrophotometer, has enabled the application of small-scale fermentations to screening of large numbers of microbes for traits such as stress tolerance. The integration of liquid handling and spectral analysis within the one automated platform couples analysis of growth with sugar consumption or production of major metabolites such as glycerol and acetic acid, and fast track the identification of strains with desirable phenotypes.

Systems Biology: the dawn of a new paradigm for wine yeast research

Staff

Dr Paul Chambers, Dr Simon Schmidt, Dr Cristian Varela, Dr Anthony Borneman, Jeremy Hack, Meagan Mercurio, Dr Daniel Cozzolino, Dr Maurizio Ugliano, Dr Chris Curtin

How do we start to unravel and reshape the amazing complexity of a yeast cell so that we can develop novel strains that will deliver wine styles determined by the winemaker? Traditionally, when attempting to understand the inner workings of an organism, biologists have isolated small components of cells and then attempted to understand what these parts do by studying them in the laboratory.

Gradually, a picture emerges on the parts being studied, but what about their roles in a living yeast cell, where they will be produced along with thousands of other components? The more we are learning about the parts that make up cells, the more we appreciate the complexity of cell physiology and biochemistry, and the clearer it is becoming that we need new approaches to exploring this.

Fortunately, a new set of technologies has emerged to help us look at the inner workings of cells in a more complete, holistic way. For example, we can now have an inventory of the protein composition of cells, known as the proteome. No longer are we restricted to following one or small numbers of proteins in an experiment; state-of-the-art analytical chemistry instrumentation is being applied in the field of proteomics to give us a comprehensive overview of the building blocks of the architecture, machinery and infrastructure of the cell.

At another level, and of particular relevance to winemakers, there is the metabolome. A metabolome is the cell's full complement of metabolites – the small molecules of a cell, including organic acids; fatty acids; amino acids; small sugars; alcohols; thiols; and more – chemicals that shape the flavour, aroma, mouth-feel and colour of wine. In a wine context, one might argue that wine is essentially the metabolomic footprint of wine yeast grown on grape juice. Using this paradigm immediately suggests new ways of approaching wine research. For example, where we might previously have targeted a handful of known metabolites in fermentation product analysis, we instead broaden the net to capture as many metabolites as possible; and we do not restrict analysis to known compounds, thereby increasing the chance of discovery. Metabolomics will undoubtedly enable a more complete description and understanding of wine composition and quality, and how these are sculpted by yeast.

How do we make sense of the massive amounts of data collected from these various 'omics investigations? The emerging field of systems biology promises to take us that last step; it utilises data from 'omics level investigations and uses computing and mathematical tools to bring it all together (see Figure 5). Once we have robust mathematical models of yeast cellular functions, we will be able to design and trial the performance of prototype novel yeast strains *in silico* (i.e. using computer models) rather than going through time-consuming, costly fermentations. Engineers in other industries have used this approach for decades: cars, aeroplanes, ships, etc., are typically designed and evaluated computationally, and only those predicted to deliver improved performance outcomes see the light of day. Computer-designed yeast, tailored to winemakers' specifications and tested *in silico*, will give Australian winemakers the competitive edge they need when faced with increasingly over-crowded markets.



A major hurdle for scientists attempting to access the 'big science' necessary to do systems biology is that it requires a broad range of expertise and state-of-the-art (and very expensive) resources. These things are not available in any single laboratory, requiring researchers to work in large consortia, collaborating to achieve a common goal. How can we take Australian wine research into this arena? Fortunately, the Australian Government has funded the development of four service delivery platforms: Genomics Australia, Proteomics Australia, Metabolomics Australia (part of which is housed at the AWRI) and Bioinformatics Australia (which provides computing infrastructure). The activities of these four platforms, whilst largely autonomous, are overseen by Bioplatforms Australia. In a coup for the Australian wine sector, Bioplatforms Australia has adopted wine yeast fermentation as a model to demonstrate how we can do systems biology in this country, with the AWRI leading and coordinating this proof-of-concept study.

Phenolics and their contribution to wine composition and sensory properties

Staff and students

Dr James Kennedy, Dr Paul Smith, Dr Keren Bindon, Dr Yoji Hayasaka, Dr Helen Holt, Dr David Jeffery, Dr Jacqui McRae, Gayle Baldock, Stella Kassara, Mango Parker, Eric Dennis (PhD student, Flinders University)

Collaborators

Australian Vintage (Bruce Kambouris); Constellation Wines Australia (Chris Bevin); CSIRO Plant Industry (Dr Simon Robinson, Dr Mandy Walker); Flinders University (Dr Michael Perkins); Foster's Wine Estates (Dr Eric Wilkes); Orlando Wines (Inca Pearce, Jai O'Toole); Patrick Iland Wine Promotions (Dr Patrick Iland); SARDI (Dr Michael McCarthy, Amy Richards); Scholefield-Robinson Horticultural Services (Dr Yasmin Chalmers); The University of Adelaide (Dr Sue Bastian, Dr Chris Ford, Dr Caroline Payne)

The Phenolics Research Team at the AWRI has the objective of determining the function of phenolic compounds in grapes and wine. Of specific interest is identifying phenolic compounds that have importance with regard to wine colour, mouth-feel, and taste. The team also has a role in developing an understanding of grape and wine phenolic attributes related to consumer wine preference. With this in mind, the effective management of these components in the vineyard and winery to achieve a targeted wine composition, or style, is the desired outcome for the team. Finally, the verification of potential and risks associated with novel practices and new technology are considered critical aspects to the projects success.

Additional scientific staff join the phenolics research team

The phenolics research team was successful in recruiting several accomplished scientists to join in the research effort. The additional staff made it possible for Dr David Jeffery to transfer to the flavour research team where he now heads up the research into aroma chemistry. In addition, Dr Paul Smith has transferred to the Industry Applications group, where he will be managing the development of tools and practical solutions from research outcomes that have progressed to the development stage.

Dr Keren Bindon joined the phenolics research team in October 2008 and will be conducting research on the role of grape production practices on the chemistry of compounds related to red wine mouth-feel. Prior to joining the AWRI, Dr Bindon was a lecturer in the Department of Viticulture and Oenology at Stellenbosch University. Dr Bindon is an accomplished research scientist and her research in Plant Physiology/Biochemistry related to wine composition and sensory properties has garnered international attention and is consistent with the goals and objectives of the research team. We are extremely fortunate to have this talented scientist on board and look forward to her contribution to the Australian wine sector.

Dr Jacqui McRae joined the phenolics research team in late June 2009 and will be conducting research into phenolic structure and function in wine. Dr McRae received her PhD in Natural Products Chemistry from Swinburne University in 2008, and conducted research on the isolation, characterisation, and activity of novel plant phenolic compounds. We are very fortunate to have Dr McRae with us and are excited about the complementary skills that she brings to the research team.

Finally, Dr James Kennedy joined the AWRI in March 2009 as Manager of the Chemistry Group. Dr Kennedy will also be leading the phenolics research effort. Prior to joining the AWRI, Dr Kennedy was an Associate Professor at Oregon State University where he spent eight years building a grape and wine phenolic research program.

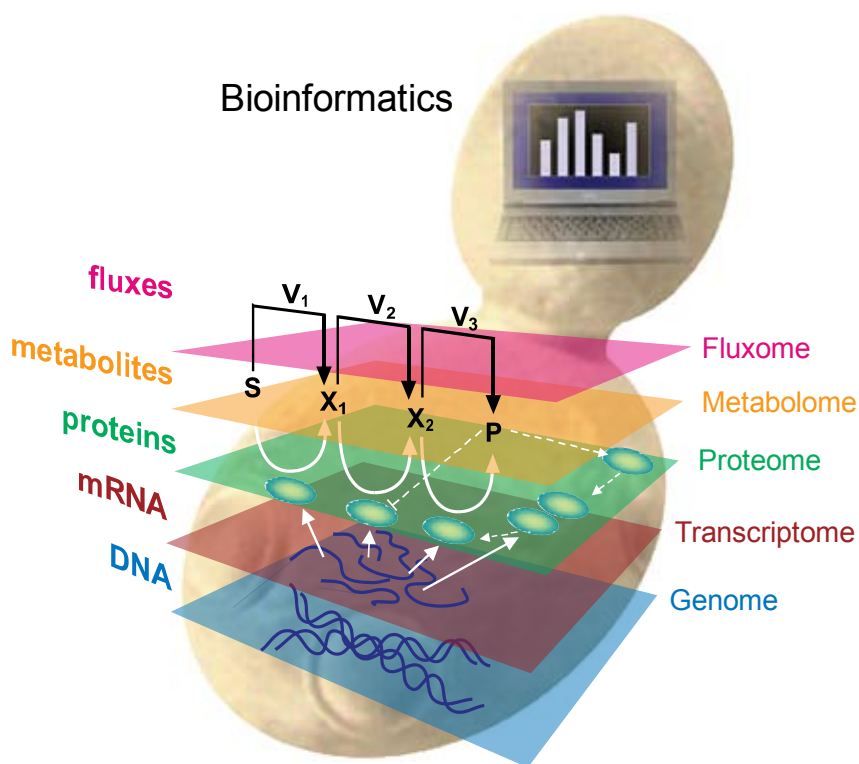


Figure 5. Systems Biology and 'Omics research. *Genomics* is concerned with characterising the genome (i.e. all of the genes and other genetic material in an organism). *Proteomics* attempts to identify the full set of proteins in a cell. *Metabolomics* deals with the complement of metabolites in an organism. Other levels of 'omics pertinent to wine research include transcriptomics and fluxomics. The first of these, *transcriptomics*, determines the transcript (also known as messenger RNA or mRNA) composition of a cell; an mRNA is a copy of the instructions carried in a gene that is read and translated to build the protein that the gene encodes. Bioinformatics provides the computational tools to handle and integrate the massive 'omics datasets that come out of these experimental approaches. *Fluxomics* is concerned with metabolism, focusing on fluctuations in metabolites and what controls their production. If we want to generate new yeasts strains that, for example, produce particular flavours, fluxomics will enable us to identify key steps in the metabolism of flavour molecules. These steps can then be up- or down-regulated to achieve the desired outcome



Team reports

Dr Kennedy was also involved in the teaching program and was instrumental in the development of a Viticulture and Enology degree program within the Department of Food Science and Technology. Dr Kennedy is an accomplished scientist and his research on grape and wine tannin chemistry has received international attention.

The addition of these scientists to our existing and talented staff ensures that the scope, depth, and relevance of our research will be maintained.



Paul Smith (L), Jim Kennedy (R)

Concentration determination of tannins in grapes and wine

The development of an assay (MCP assay) for determining the concentration of tannin in wine through precipitation with methyl cellulose is now complete, and the method has been used extensively to provide producers with sensorially relevant tannin information. The tannin database has grown and gives an overview of tannins in more than 3,000 Australian wines.

There are various methods that researchers and the wine sector use to gather tannin information and this has resulted in some confusion regarding preferred method to use. To resolve this confusion, we demonstrated good correlation for fruit and wine tannin between two of these assays: the MCP assay and a protein precipitation method.

The results of this study indicate that the two most prevalent assays in use for tannin measurement are performing similarly well and the AWRI recommends the MCP assay due to ease and complementarity with existing analytical methods in use for colour assessment.

With the wine producers in mind, the MCP assay has also been compared to a more rapid and robust spectral method for determining tannin concentrations in wine. The spectral method compares well and because of this, the rapid method is currently being built into a web accessible form (see 'Rapid measurement of phenolics in grapes and wines' report).

In summary, the development of effective, robust, and simple analytical methods that provide quantitative information on grape and wine tannins is nearing completion. The analytical information that these methods provide has been found to have utility by producers in the assessment of wine composition and astringency magnitude. With this major goal achieved, the scope of research within the research team is transitioning increasingly towards the factors that influence tannin-related sensory properties such as soft tannin and other mouth-feel attributes.

Structure/function relationship of tannins in grapes and wine.

One of the keys to driving applied phenolics research forward is to increase the fundamental knowledge of how the chemical 'structures' of grape and wine phenolics affect their 'function'. Whether the function of interest is mouth-feel, colour or perhaps bitterness, it is crucial to understand the molecular structures of the phenolics responsible. Additionally, it is critical to understand how phenolic structure influences its interaction with other wine matrix components and if these are ultimately influencing phenolic perception as well.

In research that was initiated by Dr David Jeffery, two wine tannin fractions were isolated by low pressure solid phase extraction based upon their affinity for the column material. These fractions (F2 and F3) were isolated in sufficient quantity so that sensory studies could be performed. From this, it was found that the sensory properties of the fractions differed in terms of astringency magnitude and persistence. Additional studies on tannins F2 and F3 have taken place and were designed to understand how these fractions change with wine age, and with deliberate oxidation.

The PhD research of Eric Dennis on the organic synthesis of condensed tannins is nearing completion. The coupling of monomeric units together into larger, structurally-defined tannin polymers was the focal point of this research project; such molecules are critical to understanding the influence structure has on function. He has finished his synthetic work and is currently preparing his thesis and manuscripts for publication.

This research was in collaboration with Dr Michael Perkin's Natural Products Chemistry research group at Flinders University.

Grape phenolics and their contribution to wine composition and sensory properties

It is generally accepted in the grape and wine sector that grape tannin amount and composition are not an accurate reflection of the tannins in the resultant wine. Hence it is important to understand this grape-to-wine relationship if we are to effectively manage wine tannin through integrating vineyard and winery management practices. Work is progressing well in this area of research.

We initiated a study this past year to investigate the role of fruit maturity and vine water status on the concentration and composition of phenolics in grapes and wine. With the expectation that polysaccharides have some influence on extraction and/or solubility of tannins, and on the ultimate concentration and composition of tannins in wine, we have added polysaccharide analytical methods to our suite of tools. By analysing fruit composition and comparing with the corresponding polysaccharide affinity/selectivity for tannins, the results will be compared with the composition and perception of wines produced from the same fruit.

An additional study commenced this year on the relationship between grape phenolics and wine composition. This study is being conducted in collaboration with Constellation Wines Australia. The objective of the study is to compare the phenolic composition and concentration with allocation grading provided by the winemaking staff at Constellation. Of specific interest is the relationship between allocation grading and chemistry related to mouth-feel. Parameters related to mouth-feel are being acquired, and a method for determining wine-soluble polysaccharides will be included. The sample set includes 150 wines across nine allocation grades. In addition all wines will be analysed by the spectroscopic methods so that if relationships between allocation grading and wine chemistry can be found, then a more rapid method for determination can be developed.

Coarseness in white wines

The phenolics research team worked closely with the biochemistry research team and industry partners to understand the underlying chemistry of white wine coarseness and how to minimise it during wine production. We have developed chromatography methods to evaluate the phenolics profiles in white juices and wines, and have assisted in the preparation of wines for this research. For more on the accomplishments in this area, see the report on Novel Winemaking Practices.



Novel winemaking processes to stabilise and package wine and deliver it to the consumer in optimum condition whilst maintaining or improving quality, value and sustainability

Staff and students

Dr Richard Gawel, Dr Leigh Francis, Dr Matteo Marangon, Dr Simon Schmidt, Dr Maurizio Ugliano, Patrick Dimanin, Mariola Kwiatkowski, Patricia Osidacz, Mango Parker, Ken Pocock, Brooke Travis (AWRI); Simon Nordestgaard, (PhD student, The University of Adelaide), Steven Van Sluyter (PhD student, University of Melbourne), Nick Warnock (PhD student, Flinders University).

Collaborators

Flinders University (Dr Peter Anderson, Dr Ian Menz); Foster's Wine Estates (Dr Vanessa Stockdale, Dr Eric Wilkes); Nomacorc PL, Belgium (Olav Aagaard, Jean-Baptiste Dieval, Stéphane Vidal); Pernod Richard Pacific (Leon Deans, Kate Lattey, Inca Pearce, Jai O'Toole); Provisor (Gemma West); University of Adelaide (Professor Brian O'Neill); University of Melbourne (Professor Antony Bacic, Dr Filomena Pettolino); University of Padua, Italy (Marco Lucchetta, visiting PhD student); University of Queensland (Dr Robert Falconer)

The aim of this suite of projects is to improve wine-making processes associated with getting wine into the bottle after fermentation. The current focus is on two broad areas: protein stabilisation and bottling. We are also exploring the identity of compounds responsible for coarseness in white wines. This information is a prerequisite for developing wine processing strategies to manage this negative attribute in white wines.

Protein stabilisation

Preventing protein haze is a major white wine production issue. The current method of bentonite fining is effective, but has disadvantages associated with both efficiency and cost.

Protein haze is caused by a relatively low concentration of grape pathogenesis-related proteins, namely, thaumatin-like proteins and chitinases. These proteins aggregate, resulting in light-dispersing particles and visible haziness. In any study of this problem we need easy and high-yielding protein purification procedures. This year we have combined two new methods: hydrophobic interaction chromatography (HIC) and proteomics to address this problem. This allowed us to identify all the major proteins in juice. As expected, the juice proteins were mainly grape chitinases and thaumatin-like proteins but a vacuolar invertase, PR-4 type proteins, and a lipid transfer protein from grapes were also identified. HIC also allowed the isolation of a thaumatin-like protein in a single step with high yield and >90% purity and gave us the ability to purify several other proteins.

With the availability of tens to hundreds of milligrams of purified juice proteins, we were able to begin work to obtain their structures. Although structural information would clearly be very useful for research on alternative methods to remove these proteins from wines, no one had ever been in a position to try this before. We screened many crystallisation conditions for the different thaumatin-like protein isoforms and obtained several crystal forms. In total we collected 85 crystals from the four isoforms, and examined them by X-ray diffraction at the Australian Synchrotron Facility. So far, our collaborator at Flinders University, Dr Ian Menz, has solved the structure for one of the isoforms, F2, at a resolution of 1.2 Å by molecular replacement using the banana thaumatin-like protein structure as a model (Figure 6). F2 appears to show three 'domains': a small alpha helix domain, a larger beta sheet region and an exposed loop. The protein has a charged surface on one side and a hydrophobic area on the other, with a cleft through the middle.

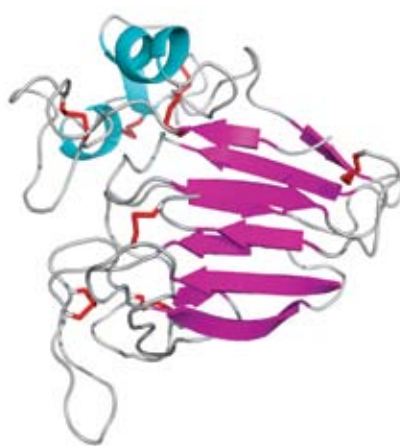


Figure 6. Secondary structure of grape thaumatin-like protein (isoform F2) with the eight disulfide bridges shown in red. This protein appears to show three 'domains': a small alpha helix domain, a larger beta sheet region and an exposed loop. This detailed information at the molecular level of wine protein structure will help us to better identify proteases and to identify those parts of the protein likely to interact with other wine components, such as phenolic compounds. This will help us to gain a more thorough understanding of the mechanisms and participants in protein haze formation, and ultimately this knowledge will contribute to the development of new technologies to control haze formation

Bottling

Packaging decisions have the potential to set the trajectory for a wine's development and should be considered as another winemaking opportunity. There have been several studies already that have demonstrated this concept and we have continued to explore the impact of bottling and packaging decisions. Our present study is on Sauvignon Blanc. In this study, two Sauvignon Blanc wines with different levels of volatile thiol compounds were bottled with the following treatments:

- » copper fining (none or 0.2 mg/L addition);
- » SO₂ adjustment (to 30 and 60 mg/L free SO₂); and
- » oxygen transmission rate (OTR) through closure (screw-cap, Nomacorc Premium and Nomacorc Light; <0.00001 mL/day, 0.003 mL/day and 0.009 mL/day, respectively).

Analysis undertaken up to 13 months after bottling showed that free and total SO₂ levels were reduced by copper addition; and increasing oxygen transmission rate (OTR). Sensory descriptive analysis on the wines showed that the differences between the wines were small. There were, however, some aspects of interest:

- » OTR (i.e. closure) had a significant effect on the score for 'struck flint', a sensory descriptor usually associated with reductive off-flavours, with the highest scores for those wines under screw-caps. However, no significant effect on 'overall aroma intensity' was observed.
- » Copper addition had no significant effect on 'struck flint', even for the wines under screw-caps. In wines bottled with 30 mg/L SO₂, but not those with 60 mg/L SO₂, a slight increase in 'overall aroma intensity' was observed with copper fining.

These results suggest that, for this wine type, closure choice might not have a large impact on the development of wines, apart from the struck flint character, over the first year in the bottle. However, it is possible that the quantity of oxygen pick-up at bottling might have been greater than the differences between the oxygen ingress over a year in the bottle. In other words, oxygen pick-up at bottling might have provided a background that made the effect of differences in oxygen ingress between the closures difficult to detect in the wine. Although the bottling was undertaken under standard commercial conditions, we did not have the technology to accurately determine the quantity of oxygen pickup at bottling. Future studies will include a better control on this aspect.

During the trial we collected four sets of analytical data from opened bottles. We had also collected Vis-NIR spectra of wines in the bottle before the bottles were opened for analysis, as well as bottle scans from another set of 12 replicate unopened bottles, for each treatment, every month since bottling. We were able to develop calibrations for total SO₂ from the opened bottles and then predict the SO₂ in all the unopened bottles. This gave us total SO₂ data for close to 300 bottles at 10 time points, non-destructively. Because the same bottles were scanned on each occasion, we are also able to track individual bottles through the post-bottling storage period.



Team reports

We also generated calibrations for free SO₂ and ascorbic acid and predicted the levels of these compounds in the other unopened bottles from the trial. The calibration statistics, particularly the residual predictive deviation, indicate that the calibrations are only suitable for screening purposes rather than analytical purposes. Still, the standard error of calibration of less than 6 mg/L for all three analytes, and the ability to follow individual bottles over time, demonstrate its usefulness in this type of study.

'Phenolic' taste in white wines

The ultimate aim of this project is to gain a greater understanding of how post-harvesting procedures and wine processing affect 'phenolic taste' in white wines and hence wine quality. It is an ambitious aim because most of the knowledge about phenolic composition and sensory qualities is focussed on red wines. The majority of the research on white wines has concentrated on the influence of viticultural practices on phenolic composition. Although different harvesting and winemaking methods are known to affect phenolic composition, very little research has attempted to measure those changes or relate them to sensory properties of resulting wine. We consider the best approach for this project is to focus on identifying the compounds responsible for 'phenolic' taste. Once we have the target compounds, we will be able to then more easily and efficiently generate data on specific processing methods that change the levels of these specific compounds of interest.

Our preliminary study has explored the relationship between wine phenolic composition and sensory attributes in commercial white wines. For this initial sensory-driven study, 24 commercial white wines were selected based on variation in palate characteristics likely to be related to phenolic compounds, such as oiliness, coarseness, astringency and bitterness, and with residual sugar less than 4 g/L. A large data set was collected from these wines: the sensory attributes of the wines were assessed by the AWRI's trained sensory panel. The consumer appeal of a subset has been assessed by 200 consumers in Sydney. The quality of the subset has been assessed by 18 winemakers from a range of wine industry partners, and the chemical composition has been determined.

The outcomes from this study were as follows:

- » The main compositional parameters related to perceived astringency were titratable acidity and the levels of total phenolics as positive drivers, with alcohol, pH, and residual sugar as negative drivers.
- » Winemakers' scores were very different from consumers' opinion. One of the most preferred wines to the consumers was rated very low by the winemakers.

- » The two main sensory attributes related to the liking scores of consumers were sweetness as a positive driver and astringency as the major negative driver. The most liked wines had higher residual sugar and low to moderate phenolics.

This preliminary study has highlighted the need to consider wines holistically and not to downplay the importance of non-phenolic compounds on the perception of 'phenolic' taste: our data clearly show that perceived astringency was related to the levels of residual sugar and titratable acidity as well as phenolic compounds, even in a sample set where all the wines had residual sugars less than 4 g/L. Furthermore, the consumer data indicate that a sizable proportion of consumers do not like wines with high perceived sourness and astringency; thus validating the need for research into this topic.

Industry Applications

Staff

Peter Godden, Dr Paul Smith, Dr Daniel Cozzolino, Dr Bob Damberg, Dr Wies Cynkar, Dr Richard Muhlack, Dr Chris Curtin, Ella Robinson, Emma Kennedy, Nevil Shah

Collaborators

Brucker Australia (Andrew Bales); CAMO Australia (Brad Swarbrick); Constellation Wines Australia (Chris Bevin, Jim Northey, Handoko Putra, Greg Balkwill); CSIRO Entomology (Stephen Trowell, Amalia Berna); CSIRO Land and Water (Anu Kumar, Jeff Baldock); DPI Queensland (Heather Smyth); Foster's Wine Estates (Eric Wilkes, Allen Jenkins, Pascal Marty, Paul Petrie, Brenton Porter, Allen Hart); James Cook University (Danny Coomans, Yvette Everingham); Jeffress Engineering (Collin Jeffress); McGuigan-Simeon (Bruce Kambouris); Orlando Wines (Inca Pearce, Jai O'Toole, Kate Lattey, Leon Deans); Petaluma Wines (Andrew Hardy, Mike Mudge); Tamar Ridge Wines; Tarac Technologies (Chris Zajac); University of Adelaide (Steve Tyerman, Eileen Scott, Belinda Stummer, Peter Ashman, Philip van Eyk, Adam Kosminski, Brian O'Neill, Nicholas Hon, Torbjorn van Heeswijck, Elizabeth Cooter); University of South Australia (Miguel de Barros Lopes); Victoria University (Grant Stanley); The Yalumba Wine Company (Greg Edwards, Cecil Camilleri, Andrew Murphy, Geoff Linton, Simon Dillon)

The Industry Applications (IA) Group has focussed on reprioritising directions to reflect industry's changing needs and on progressing the technical aspects of several major projects. A reasonably new group in the history of the AWRI, the IA Group essentially takes primary responsibility for the 'D' in the AWRI's RDE&C model. The group works closely with other teams at the AWRI, external research collaborators and with industry partners to more effectively bridge 'gaps' that might exist between research and

application, and further break down barriers to uptake. The IA Group pro-actively assists wine sector personnel to apply practical knowledge generated from both inside and outside the AWRI. Identifying the barriers to application of knowledge and research outcomes is critical, for example determining whether there is a technical solution that is missing, or perhaps a requirement for more education and awareness around a topic. Demonstration of the financial and sustainability benefits that come from knowledge application is also crucial, as is the development of new products and technological solutions that arise from research programs. In a global R&D marketplace and an era of cross-border ownership, Australia's continued success will be linked to its ability to apply new technology rapidly; speed to market is a key consideration.

The IA team focuses on four main areas, among which there is substantial integration:

- » Economic and environmental sustainability and process improvement;
- » Regionality;
- » Smart technologies; and
- » Integrated solutions.

Planning for environmental and business sustainability

At this time of unprecedented global economic instability, the Australian wine sector is under intense pressure on many fronts. Rising energy costs, together with currency volatility, finance costs and credit availability are all impacting on bottom-line profitability. Climate change and water shortages are real and immediate threats and continue to be of growing concern across all sectors of the community. Market and social pressures relating to carbon footprint, emissions trading, peak oil, food-miles, and sustainability further add to the mix.

Amidst this uncertainty, it is essential for business and environmental sustainability that vital natural resources are sourced and managed in the most efficient way possible. Engineering tools and process knowledge are available now to meet this need by delivering process improvement and efficiency gains across a range of areas.

For example, engineering process control strategies seek to reduce resource demand by providing real-time online monitoring and control towards quantified quality targets. Real-time data monitoring combined with a suitable process model can also be used by computer simulation to identify and predict problem fermentation behaviour. As a result of partnerships at the AWRI, a new hybrid simulation model has been developed, with an emphasis on simplicity and robustness. The nature of the regression method and model parameters

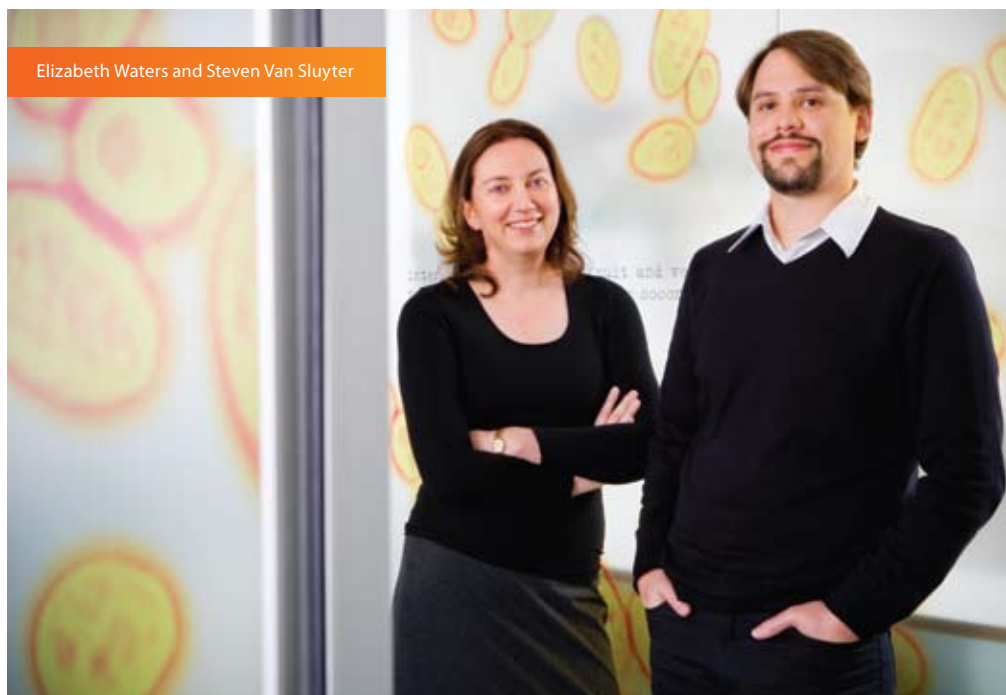


used enables the model to be fitted to a wide range of laboratory and commercial ferment data. In particular, the methods have shown particular promise for predictive capability when applied to commercial ferment data. In conjunction with this work, a system of online electronic pressure sensors was developed and employed during the 2009 vintage to measure and log fermentation progress across a number of red ferments. Although this work is ongoing, results to date are very promising with sensor performance correlating very closely with predicted behaviour. Insights gained this vintage will guide future trial design and proof-of-concept evaluation for this technology and enable fermentation instrumentation to be effectively tailored to winery facilities of different sizes.

Potential winery process areas where significant high impact and/or low cost efficiency improvements are typically found include: refrigeration control; process heating and waste heat recovery; hot water generation; air compressor performance; and wastewater treatment. The AWRI has been working to develop resources to highlight high impact sustainability improvements such as these, and to assist the wine sector to overcome adoption barriers that impede uptake of these opportunities. Business cases have been developed for a range of these initiatives which demonstrate annual process cost savings for different facility sizes. This information is currently being compiled into 'information packs' which will subsequently be available on the AWRI website and for presentation via existing AWRI extension channels.

Opportunities also exist to add value to winery processes and waste streams through renewable energy technology such as biomass electricity, liquid biofuels and solar thermal systems. To this end, the AWRI is currently undertaking a scoping study (funded by the Australian Government Department of Agriculture, Fisheries and Forestry) of grape marc and stalks as a fuel source for low-emissions renewable power generation using combustion and fluidised-bed gasification technology. Initial marc gasification testing to date indicates very favourable gasification performance, although high potassium and fuel moisture are presenting challenges in terms of fluid-bed fouling and solids handling. These issues and potential mitigation strategies will be evaluated over the course of subsequent laboratory trials before being reported to industry together with recommendations for further development.

Preliminary investigations have also commenced into opportunities for production of ligno-cellulosic bioethanol and other high-value specialty chemicals from winery biomass. This 'biorefinery' approach would have many advantages for the Australian wine sector due to existing process infrastructure, relevant industry and scientific expertise, and existing markets for these value-adding products. Developments in this area and discussions with potential research and industry partners are continuing.



Elizabeth Waters and Steven Van Sluyter

Innovative application of these renewable energy opportunities will allow our industry to further improve resource recovery, reduce costs, and minimise environmental impact. Such initiatives will be crucial to maintaining our competitive advantage while we adjust to the carbon constrained economy of the future.

Helping to define regionality

The Australian grape and wine sector is regionally diverse, and has a demonstrable ability to produce an equally diverse range of wine types, and within-varietal wine styles. However, there is little objective data or information available that elucidates the factors that influence regional differences, or data that allows an understanding of Australian regional wine styles in a global context. In addition, climate change is likely to have an effect of shifting current regional style. IA projects can plot such shifts, thus potentially allowing grape and wine producers to mitigate the impact of climate change or even harness it for improved wine quality; a beneficial change in wine style or objective definition of styles; or the development of novel wine styles within their region.

This project seeks to objectively investigate and to define regional differences in grape and wine composition and wine styles, and in processing differences that might have a regional basis. Possible impacts of various processing options in modulating regional characteristics are investigated. This information is then provided to grape and wine producers in a way that allows greater understanding of the factors that lead to regionality and how those factors might be manipulated. IA team members are always interested to hear from regional organisations about technologies and applications which might be of benefit to their particular region.

Rapid measurement of phenolics in grapes and wines

Applications such as the analysis of total anthocyanins in grapes, using Vis-NIR spectroscopy, have been adopted by producers. To complement the analysis of anthocyanins it is desirable to also analyse tannin, as the two combine in wine to form pigmented tannins, the stable form of red wine colour. The AWRI has developed a simplified wet chemistry method (the 'MCP tannin method') to measure tannin in grapes and wine, and this has now been taken one step further through the development of rapid spectral methods using UV, Vis, NIR and MIR spectroscopy.

To maximise access for Australian practitioners to this rapid predictive method for tannin, a web-based interface has been developed over the last year. This 'tannin web portal' will allow people to quickly determine tannin concentration in their own facilities as long as they have a single-read or scanning UV-Vis instrument. Such instruments are widespread in the Australian industry. In addition to the wine tannin concentration, users can obtain a 'context' report that will show them the concentration of their wine in relation to other wines by vintage, variety or even region (Figure 7). This means that single pieces of data can more easily be turned into knowledge to support the decision making process.



Team reports

Shiraz Tannin Concentration by Region

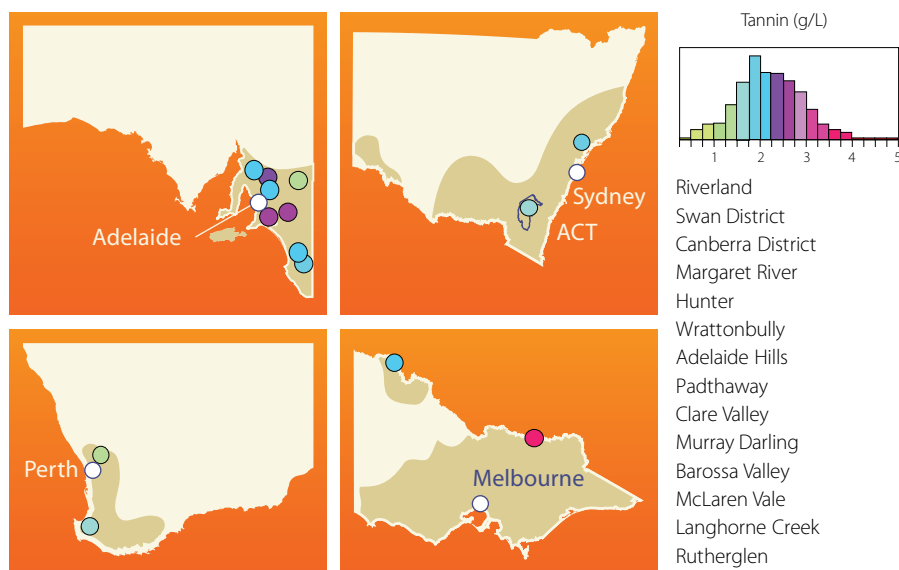


Figure 7. An innovative 'web portal' for calculating wine tannin concentration in wine will soon be available allowing tannin concentrations to be put in context by relating to other wines from a vintage, variety or region

While a method using a standard UV-Vis spectrophotometer might be advantageous for a smaller laboratory that does not have access to NIR or MIR devices, using the IR wavelength regions has the advantage that many other analyses can be performed simultaneously. For example, we have now demonstrated that with the same Vis-NIR scan, anthocyanins, tannins, total dry matter, water content, total soluble solids and pH can be rapidly measured in red grapes. As appropriate equipment and software becomes more affordable and more versatile, these methods will become main-stream in industry.

Affordable, multi-functional instruments for rapid grape and wine analysis

Research at the AWRI has long demonstrated the capacity of spectroscopy to rapidly predict multiple grape and wine composition parameters. However, access to affordable spectroscopy instruments that have been robustly tested for use with grapes and wine has slowed the widespread adoption of these methods. To address this, the IA's Rapid Analytical Methods (RAMS) team have partnered with other businesses to ensure the availability to Australian producers of affordable instrument solutions.

The availability of affordable, 'off-the-shelf' spectroscopy instruments is improving. One such mid infrared (MIR) instrument with an ATR cell that is easy to clean and maintain, has been tested this year and proved itself in 'active service' in a busy laboratory in vintage 2009. Such real-world demonstrations are critical to ensure the suitability of instruments and this instrument should be available in the next year or so.

When 'off-the-shelf' spectroscopy instruments for a particular application are not available, custom design is required. One such example is the BevScan instrument for rapid, non-destructive in bottle measurement (Figure 8). Developed as a partnership between the AWRI, Jeffress Engineering in Adelaide and Camo ASA of Norway, the BevScan is capable of identifying specific parameters in wine and classifying unknown bottles of wine without opening the product, all within just a few seconds. In classification mode, no knowledge of spectroscopy is required and the software interface is easy to use. While still in the final stages of refinement, it is anticipated that the instrument will be launched commercially in the fourth quarter of 2009.

Rapid measurement of plant water status

Modern technological developments in positioning, sensing, and control systems have opened a new era in which many traditional agricultural practices are being left behind. Replacing them are 'precision farming' techniques in viticulture. These techniques manage variability within a field by applying agronomic inputs in the right place, at the right time, and in the right quantity to reduce the environmental impact of modern grape and wine production. Recent environmental developments have created increased demand for in-field measurement of soil and water constituents. For example soil carbon pool measurements are needed to study carbon sequestration, and measurements of soil nitrogen could be used to manage and minimise the leaching of nitrates into the ground water. Research has been initiated on the use of in-field sensors based on visible and near infrared (Vis-NIR) spectroscopy to enable the rapid and non-destructive analysis of chemical and physical properties of soil and plant components in the vineyard. If this method could be applied *in-situ* without substantial loss of measurement accuracy, then a rapid field analysis of

soil would be possible. Studies across a wide range of vineyard, regions and soil types commenced during the 2008-2009 season, and preliminary results were reported in a wine industry journal.

To make informed irrigation decisions, a measure of the level of plant water status is the ideal option, provided such a measure is simple to use, correlates robustly with actual plant physiological parameters and can be integrated over many samples. Vine water status can be monitored by measurements of soil water, water balance modelling or using physiological indicators. Water potentials in vascular plants can be measured by means of a pressure chamber in order to estimate leaf water potential, pre-dawn leaf water potential and stem (petiole) water potential.

The pressure chamber technique of measuring leaf and stem water potential has been assessed in several cases for grapevines as a relatively simple measurement. However, the technique requires destructive sampling, pre-treatment for up to an hour for stem water potential, and is prone to operator errors if certain precautions are not taken.

In the near infrared (NIR) region, several wavelengths (e.g. 950 nm, 1400 nm and 1900 nm) are strongly influenced by the presence of water and the particular state of water in the measured sample. A collaborative study is underway between four Wine Innovation Cluster (WIC)-partners (AWRI, SARDI, The University of Adelaide and CSIRO) to integrate different methods to assess and manage water in the vineyard. In particular, the AWRI is developing a NIR method combined with multivariate analysis that will relate NIR absorption spectra with physiological measures of leaf water status measured in field grown Shiraz, Cabernet Sauvignon and Chardonnay grapevines. In this preliminary study



Figure 8. The 'BevScan' instrument for rapid, non-destructive in bottle measurement has been developed as a partnership between the AWRI, Jeffress Engineering in Adelaide and Camo ASA of Norway, and is capable of identifying specific parameters in wine and classifying unknown bottles of wine without opening the product, all within just a few seconds



leaf samples were taken from different treatments and analysed using a portable Vis-NIR instrument (800 – 1800 nm) in reflectance. Partial least square (PLS) calibrations between reference and NIR data were developed using cross validation. Preliminary NIR calibrations yielded good correlation coefficients between predicted and measured stem and leaf water potential ($r > 0.60$, Figure 9). These functions appear to hold within a variety for several weeks of measurement. It is also possible to determine clear trends in the spectra that would allow a rapid detection of the onset of water stress.

Objectively defining Pinot Gris and Pinot Grigio wine style

Pinot Gris is a white grape variety that is growing in importance in the Australian wine sector. However, because this variety has two different names (Pinot Gris and Pinot Grigio), and has traditionally been used to make wines of very different styles, there is potential for considerable confusion amongst consumers which could impact on the variety's ultimate success in the marketplace. Our work on this variety aims to gain a greater understanding of Australian styles of Pinot Gris/Grigio wines, in a global context. A combination of sensory analysis, chemical analysis and rapid spectroscopy techniques has demonstrated that objective measures of Pinot Gris/Grigio style can be achieved. This could provide wine producers with information to better communicate with consumers, and potentially label wines more consistently. Communication of the findings to the wine sector will be a focus of the coming year.

In summary, the key to the success of the Industry Applications model will be to ensure that all of these technologies are combined into packages which have relevance to the Australian grape and wine sector – what we term 'integrated solutions', and that those 'integrated solutions' are actually implemented into production practices.

Applications of mass spectrometry to ensure the quality and integrity of Australian wine

Staff

Dr Yoji Hayasaka, Gayle Baldock

The members of the Mass Spectrometry team work collaboratively across teams within the AWRI and also with external researchers. Their collaborative activities are included elsewhere within this report, however, the highlights from the year are shown here.

Investigation of taint problem using mass spectrometry

Collaborators

Winemaking and Extension team of the Industry Development and Support Group

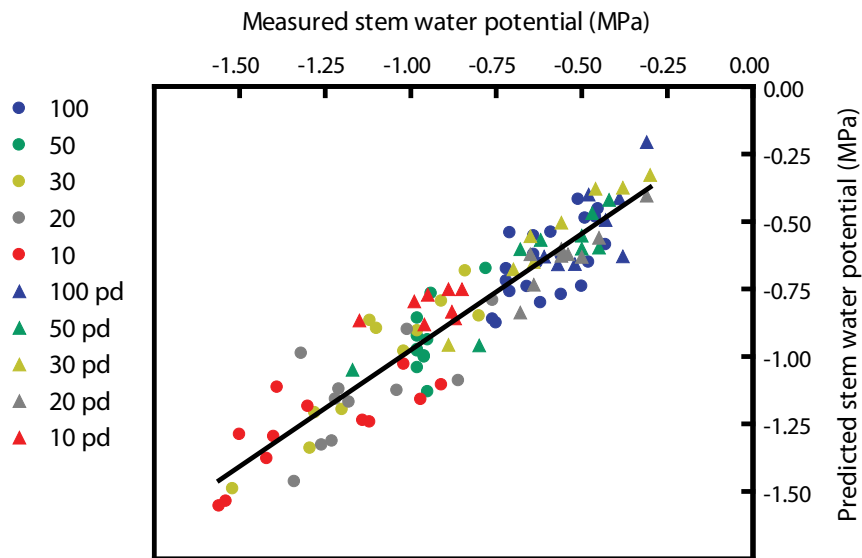


Figure 9. Predicted Stem (Petiole) Water Potential (SWP) versus measured SWP using NIR spectra for Chardonnay vines measured in January and February. Each absorption spectrum was measured on the underside of a leaf on the same shoot as an adjacent bagged leaf used to measure SWP. Irrigation treatments are indicated with different coloured symbols (pd = pre-dawn)

Mass spectrometric techniques were applied for various separate taint investigations. These included investigations into 'burnt rubber-like' aroma in red wine, off-flavour and taint caused by containers in various wines, wine affected by filtering through suspected tainted earth, wines exposed to excessive heat in a warehouse and an unusually high production of indole in wines. See the 'Technical problem solving and consulting' report published in this Annual Report for further details.

Investigations into smoke-affected grapes and wine

Collaborators

Technical problem solving team of the Industry Development and Support
Dr Kerry Wilkinson and Kerry Dungey of the University of Adelaide

In recent years, the negative impact of bushfire on grapes and their resulting wines is an increasing concern. The wines made from grapes exposed to smoke in vineyards are often characterised by objectionable 'smoky', 'dirty' and 'burnt' aromas and tastes. This can result in significant reductions in their market values or even make the wine not fit for sale.

Guaiacol has been used as a marker to assess the smoke-affected grapes and wine. The reasons for that are (i) guaiacol is one of the most common smoke-derived compounds; (ii) has a strong smoky character; and (iii) most importantly, its concentration in juice and wine samples has been strongly correlated with the intensity of the smoke affect (2003 AWRI annual report). However, in some instances, grapes containing very low or not detectable (less than 1 µg/kg) concentrations of guaiacol have produced smoke-affected wine.

This observation suggests that a better marker or way to assess the degree of smoke affect to grapes and wine is needed.

We are currently working on two approaches to develop a better way to assess the potential of grapes to produce smoke-affected wine. These are:

- 1 Can guaiacol precursors be used as markers to indicate a degree of smoke affect to grapes and wine?

It has been reported that guaiacol precursors are biotransformed from guaiacol and accumulated in grapes as a consequence of grapevine exposure to smoke. A portion of these precursors release free guaiacol during fermentation and possibly during maturation and even in-bottle. Therefore the precursors are good candidates for markers to assess the degree of smoke-affect.

Initially, the identification of guaiacol precursors was carried out using stable isotope technique. A brief protocol of this experiment is as follows: (i) the aqueous guaiacol solution (5 mg or 30 mg/L) containing the unlabelled (*do*) and labelled (*d3*) guaiacol at an equal amount ratio was prepared; (ii) two pots of grapevines (Cabernet Sauvignon) were prepared: one was treated with guaiacol and another was untreated (control); (iii) the *do*- and *d3*-guaiacol solution was poured in a plastic bag with a seal and then a leaf or a bunch of grapes was placed in the bag, allowing to directly contact with the guaiacol solution for one or two days; (iv) the leaves and grapes were collected from the treated and untreated pots of grapevines at six weeks after contact with the guaiacol solution; and (v) the leaf and grape samples were analysed by LC-MS and LC-MS/MS techniques.



Team reports



(L to R) Yoji Hayasaka, Heather Brooks, Gayle Baldock, Markus Herderich, Sarah Ballantine, Randell Taylor, Marcel Essling, Con Simos

As a result, the following observations and findings were made:

- » Significant abundance of seven different glycosides (shown below) of *do*- and *d3*-guaiacol was found in the leaves and berries which had been directly contacted with the guaiacol solution.
- » Only trace amounts of the unlabelled (*do*-) and labelled (*d3*-) glycosides (*do* >> *d3* in abundance) were found in the leaves and berries with no contact with the guaiacol solution, collected from the treated grapevine. This observation demonstrates that the translocation of the guaiacol glycosides is limited within the grapevine.
- » Trace amounts of the unlabelled guaiacol glycosides were found in the control leaf and grape samples collected from the control grapevine. This observation demonstrates that these guaiacol glycosides are present as natural components of grape berries and leaves.
- » The leaf and berry samples contained the same guaiacol glycosides but had a different relative abundant distribution of the glycosides. The monoglucoside is most abundant in the leaf accounting for nearly 70% of total glycosides but is the least abundant in the berry samples in which total diglycosides are dominant accounting for more than 75%.

The seven guaiacol precursors were also found in the leaves and grapes which had been exposed to smoke resulting from the Black Saturday Bushfire that occurred in February 2009 in Victoria. Hence, the stable isotope trace experiment simulated the fate of guaiacol taken in by leaves and berry which had been exposed to smoke.

A method for the semi-quantification of total guaiacol precursors (sum of seven precursors) in berries using HPLC-MS/MS was developed and applied for analysis of smoke-affected grapes obtained from the bushfire-affected areas in Victoria. In total, 26 samples were analysed and the lowest and highest concentrations were at 0.026 and 3.041 mg/kg, respectively. Importantly, all samples were found to contain a detectable level of guaiacol precursors, including a control sample (not smoked). On the other hand, 11 (42%) out of the same sample set (26 samples) showed no-detectable level of guaiacol and the 38% showed only very low concentrations (1 to 5 µg/kg).

In conclusion, guaiacol precursors are promising markers to assess a degree of smoke-affect to grapes and wine. The analysis of these precursors is expected to be useful as a risk management tool for making decisions regarding whether suspected smoke-affected grapes can be used for winemaking. The investigation is in progress.

- 2 Can smoke sampling be used to indicate smoke exposure intensity in a vineyard (airborne analysis)?

This approach aims to measure smoke intensity in a vineyard during a bushfire event and use the smoke intensity data to assess the extent to which smoke has impacted on grape quality. In addition, sampling of smoke during a particular fire event may provide an indication as to what other compounds might be present in concentrations that might cause a smoke affect in grapes and wine (other than guaiacol).

Passive (diffusion) and active (pump) smoke sampling techniques using two different adsorbents (TENAX and PDMS) were tested in tents enclosing grape vines filled with smoke from burning straw (model experiment). The trapped smoke-derived volatile compounds on the adsorbents were analysed by GC-MS combined with TDU (Thermal Desorption Unit) and CIS (Cooled Inlet System). These sampling techniques were also tested in a prescribed burn-off in the Adelaide Hills in order to better understand the applicability of these methods in a realistic smoke event.

In all experiments, all methods were able to analyse a broad range of smoke-derived components. Guaiacol and methyl guaiacol were easily measured, as were other typical 'biomass burn'-generated compounds including a variety of alkylbenzenes, naphthalenes, phenols, methoxyphenols and



syringols, etc. The active methods (pump) were found to be a better way to analyse smoke than the passive methods, which sensitively detected a greater number of compounds. The active TENAX method was able to pick up more compounds than all other methods. The passive TENAX 'badge' was the least sensitive method both in the model experiments and in the real situation.

The twister (PDMS) passive method was able to pick up a similar number of compounds as the PDMS active method with less intensity. When the twistors were left for 24 hours in the bush during and after the prescribed burn in different areas (low and high visible smoke intensity) it appeared to be capable of quantitatively measuring the range of smoke intensity. Also, results from duplicate samples in each area illustrated good repeatability of the method.

In conclusion, the twister is a practical method of sampling smoke in the vineyard. It is suited to rapid deployment in a bushfire situation and would provide suitable results for this type of effort. More work is required to further assess the potential of the twister for this application (including a better design for deployment, understanding the sorbents ability to retain compounds under laboratory and natural variations in weather such as temperature and rain etc.).

If, in the future, we could combine air sampling during a smoke exposure event with grape and wine analysis from the specific vineyard we could possibly develop an early warning risk assessment tool for grapegrowers who are concerned about their grapes being smoke affected.

Technical problem solving and consulting

Staff

Adrian Coulter, Geoff Cowey, Matt Holdstock, Gayle Baldock, Emma Kennedy, Con Simos and Dr Yoji Hayasaka

During the year, the name of the former Industry Services was changed to 'Winemaking and Extension Services' in order to better reflect the assistance provided to the Australian wine sector; such assistance includes a range of advisory, problem solving, extension and information services. In addition to its extension and information transfer activities, which are discussed elsewhere in this report, the Winemaking and Extension Services team provides a technical problem solving and analysis service to the Australian wine sector. The primary aim of the service is not only to provide diagnoses of the causes of various problems, but to offer preventative and remedial advice based on the cumulative problem solving and practical winemaking experience of the staff. As previously reported, it is clear that quality loss during wine processing and packaging represents a major cost to the Australian wine sector. Consequently, all the activities of the Winemaking and Extension team, in terms of problem solving, extension and information transfer, aim to address this issue in a targeted manner, such as previously exemplified by the closure trial and 'Brett' projects, and currently illustrated by our 'taints' workshop 'The avoidance of taints and chemical instabilities during winemaking'; our 'Packaging' workshop, which is currently being developed; and our involvement with research on smoke taint from bushfires.

The technical problem solving service represents a significant proportion of the team's workload and is provided according to strict Terms and Conditions, and client confidentiality is an important aspect of the provision of the services. This facilitates a frank exchange of information between the AWRI and its clients, which in turn allows the maximisation of the knowledge gained from the provision of these services. If a particular problem is considered to be of interest to the wider wine sector, the results of investigative work are made available through relevant publications, and the Winemaking and Extension Services team contributes regular articles to *Technical Review*. However, under no circumstances is the name of the winery or company concerned, or any possible identifying references, ever published.

A summary of the enquiries received by Con Simos, Adrian Coulter, Geoff Cowey and Matt Holdstock for the year is shown in Table 1, with comparison figures for the previous two years.

Table 1. Enquiries received by Winemaking and Extension Services advisory staff in the period 2006/2007 to 2008/2009

	2006/2007	2007/2008	2008/2009
Wineries	1285	1244	1024
Government organisations	36	48	36
Other	369	150	160
Students	21	15	16
Total	1711	1457	1236

Compared with the previous year, the figures for 2008/2009 show a 15% decrease in the total number of enquiries received. The decrease has largely occurred through the 'wineries' category and may partly reflect the decline in the winegrape crush in 2009, which was about 7% lower than the previous year. Nevertheless, the number of enquiries received from wineries is significant and indicates that a large number of Australian wine producers continue to regard the AWRI as a trusted, reliable, and an important source for quality technical information and problem solving solutions.

A proportion of the investigations conducted by the team relate to disputes arising between levy-payers or between levy-payers and suppliers of either materials or contract services. Consequently, and with great sensitivity, Winemaking and Extension Services staff members often find themselves in a mediation role in these disputes, and spend a considerable amount of time providing technical information to legal professionals representing grapegrowers and wine companies. Fortunately however, the majority of disputes are settled before formal court proceedings are instigated, which is of great benefit to clients.

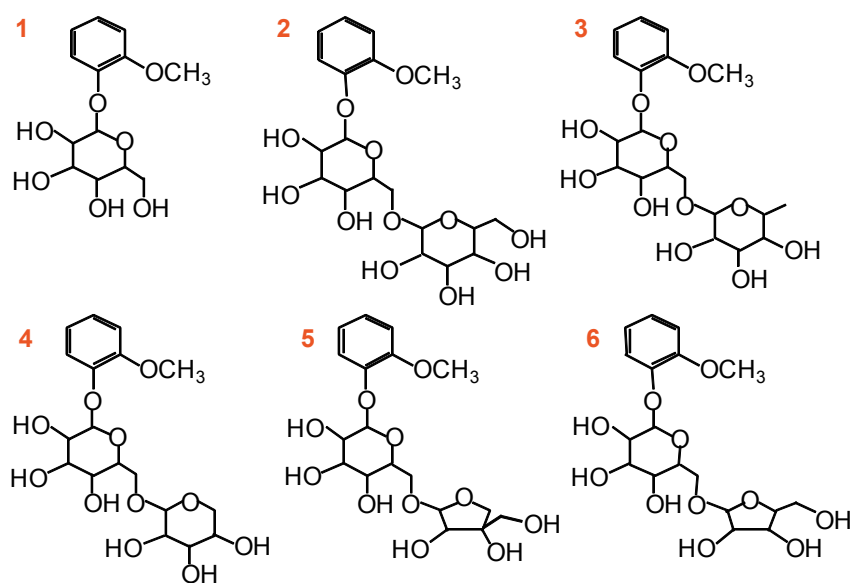


Figure 10. Proposed structures of guaiacol precursors found in the grapes and leaves directly contacted with guaiacol solution, **1:** glucoside (glu), **2:** gentiobioside (glu-glu), **3:** rutinoside (glu-rhamnose), **4:** glu-xylopyranoside and – arabinopyranoside, **5:** glu-apiofuranoside, **6:** glu-arabinofuranoside



Team reports

Full reports, containing technical information relating to the problems investigated, are prepared for clients when investigations are likely to result in litigation. Otherwise, clients are provided with summaries which seek to explain the underlying causes of the problems encountered, or are directed to relevant sections within the Winemaking and Extension Services section of the AWRI's website. Advice on how to prevent the re-occurrence of such problems is provided to clients and technical references relating to the area of investigation are also often supplied.

A summary of the number and type of investigations conducted by the Winemaking and Extension team over the past three financial years is presented in Table 2.

Table 2. Summary of the number and type of problem solving investigations conducted, and numbers of samples analysed by the Winemaking and Extension team during the past three years

Type of investigation	Investigations conducted and samples analysed		
	2006/07	2007/08	2008/09
Identification of hazes and deposits	74	70	64
Microbiological investigations	36	19	27
Sensory assessments	26	33	67
Taint problems	80	58	31
Other investigative analyses	36	25	31
Closure-related investigations	26	4	6
Total number of investigations	278	209	226
Total number of samples analysed	2000	1042	1042

The figure for the number of investigations conducted during 2008/2009 is 8% higher than the figure for the previous year, whilst the total number of samples analysed as part of these investigations remained the same as the previous year. The number of investigations conducted into wines affected by hazes and deposits has continued to decrease, however, the number of these types of problems investigated continues to represent a considerable percentage (28% for 2008/2009) of the total number of investigations performed. Consequently, issues related to such instability problems continued to be addressed during the AWRI's Roadshow workshops during the year and also by the Winemaking and Extension Services section of the AWRI's website.

Although slightly higher than the previous year, the number (27) of investigations conducted into microbiological instabilities has remained low relative to the period from the 1999/2000 to 2004/2005, during which the average number of microbiological investigations conducted per year was 62. Despite the encouraging downward trend in the frequency of this type of investigation, a substantial number of wine samples continue to

be received with microbiological instability, often resulting in a haze or deposit having formed after bottling. Bottling issues have also represented a large proportion of the queries received by the Winemaking and Extension Services team in recent years. Consequently, instabilities and other issues relating to bottling are now being addressed with the development of a 'packaging workshop', which is to be presented during the AWRI's Roadshows from September 2009.

There was a substantial increase in the number of investigations conducted under the category 'Sensory assessments', with the number for the current year being just over double that for the previous year. A downward trend in the number of investigations conducted under the category

'Sensory assessments' was observed during the period 2002/2003 to 2006/2007, when the numbers of these investigations conducted decreased from 72 to 26. However, that downward trend has rapidly reversed over the past two years (Figure 11).

The types of investigations carried out under the 'Sensory assessments' category include those conducted into wines reported to be exhibiting 'reductive' characters or wines reported to be affected by 'unknown' or 'unusual' sensory characters; wines showing 'deterioration' or bottle to bottle 'variability' after packaging; or wines that might have been the subject of a 'customer complaint'. Sensory evaluation is an important analytical and research tool, and is also commonly used in problem solving investigations classified under other categories, such as 'Microbiological investigations', 'Taint problems' and 'Identification of hazes and deposits'.

The number of taint investigations conducted has steadily decreased since the 2005/2006 financial year, when there was a 'spike' in the number due to investigations into 'plastic/chemical-like' taints, the majority of which were due to the use

of a particular batch of tartaric acid that was tainted with 2,6-dichlorophenol. The figure (31) for the number of taint investigations has now decreased to below the average figure (45) calculated for this category for the period from 1999/2000 to 2004/2005 (Figure 12). These data might indicate that, at least in part, the strategies for avoiding taints and contaminations advocated in the 'taints' workshop, which we have delivered as part of the AWRI's Roadshows since 2006, are being adopted by the Australian wine sector.

It is encouraging that only two post-bottling cork-type taint investigations were conducted during the year, suggesting that the incidence of this type of problem might be decreasing. In each case, natural corks affected by 2,4,6-trichloroanisole (TCA) were determined to be the cause of the problem. The estimates of the incidence of taint in these two cases were 17% for one wine and 25% for another, indicating that cork-type taint can cause serious difficulties when it occurs. The general downward trend in the number of cork-type taint investigations conducted might be the result of the wine sector's increasing use of alternative closures to natural cork.

A particularly interesting investigation was conducted into a red wine that had developed a taint, which the winemaker described as 'nutty' and 'earthy'. The winemaker observed that the fruit had been damaged by birds and that 'ladybugs' had been attracted to the fruit as a consequence of this. The winemaker suspected that the 'ladybugs' might have been the cause of the taint and requested that the AWRI investigate. The affected wine and a similar wine from the same estate, that the winemaker indicated was not affected by the taint character, were tested for a range of methoxy-pyrazine (MP) compounds, as particular MP compounds have been identified as the cause of 'ladybug taint' in other countries (Kotseridis et al. 2008). The compound sec-butyl methoxy-pyrazine (SBMP) was detected at a concentration of 18 µg/L in the wine suspected to be affected by 'ladybug taint', whereas no MP compounds were detected in the similar wine. Whilst Kotseridis et al. (2008) indicate that isopropyl methoxy-pyrazine (IPMP) is the most prevalent MP compound associated with the taint from red wine fermented with live Multicoloured Asian Lady Beetles (MALB), these authors indicate that the MALB can also contribute to elevated SBMP concentrations in wine. Hisakatsu et al. (1984) indicated that the threshold of SBMP was 2.0 ng/L in water and although a higher threshold might be expected in wine, it is likely that the level of SBMP detected in the red wine suspected to be affected by 'ladybug taint' contributed to the taint character observed by the winemaker.

During the year, 31 investigations were conducted under the category 'Other investigative analyses'. Although the figure for the number of investigations conducted under this category is higher than the figure (25) for the previous year,



the number of investigations conducted under this category has steadily decreased since the 2004/2005 financial year, when 67 such investigations were recorded. The types of investigations recorded under the category 'Other investigative analyses' are extremely varied, and include topics such as pinking problems; filtration problems associated with polysaccharides; post-bottling 'Brett' issues; increases in titratable acidity during fermentation; and issues associated with the possible dilution of wine with water.

The marked decline in the number of samples submitted with closure-related problems observed for the previous year has continued this year, with only six such investigations recorded. This is an area in which Winemaking and Extension Services staff have been highlighting the issues for many years, so it is pleasing to observe a decline in the number of closure-related problems.

During the 2009 vintage, Winemaking and Extension Services staff spent a large amount of time dealing with both the heat wave that affected South Eastern Australia in late January and the devastating fires which began in Victoria on 6 February. As a part of the AWRI's response to these issues, two Email bulletins were sent out to Australia's winemakers. The first bulletin dealt with the 2009 heatwave and the effect this had on vines, and the second bulletin provided information on smoke taint that could arise from the bushfires. Both of these bulletins contained links to further information available from the AWRI's website and other websites, such as the Department of Primary Industry Victoria (DPI Vic) and the Grape and Wine Research and Development websites. The AWRI website received 1,372 hits in response to the heatwave bulletin and 1,850 hits in response to the bushfire/smoke taint bulletin, indicating that a large number of personnel in the Australian wine sector regard the AWRI as an important or primary source of technical information.

From the onset of the bushfires, the AWRI worked very closely with the Victorian Wine Industry Association and DPI Vic, to formulate an assistance plan. A series of initiatives were quickly developed to enable grapegrowers and winemakers to best determine the extent of the problem. These initiatives included dissemination of information on smoke taint mitigation management strategies, including the Email bulletin mentioned above, and the implementation of a 'fast-track' analysis service that was compliant with quarantine regulations for the prevention of phylloxera and fruit fly. The AWRI's Commercial Services laboratory is one of few laboratories that offer guaiacol and 4-methyl guaiacol analyses, two important smoke taint marker compounds, so it was essential that vignerons could despatch samples quickly and receive results promptly.

In order to fast-track collection and dispatch of samples, the DPI Vic set up a number of collection points where samples were frozen for 24 hours. Once this quarantine requirement was met, samples were dispatched by air freight overnight and the AWRI's Commercial Services collected the frozen grape samples from Adelaide airport the next morning. The documentation was also streamlined by maintaining an accreditation through Primary Industries and Resources South Australia to be a licensed importer of plant material. The system worked extremely well, with collaboration between all parties resulting in transit times being reduced to less than one day. These initiatives contributed to a reduction in the turn around time of the analysis to three working days. As a further gesture of good will, the standard price for smoke taint analysis was decreased.

By the end of April, over 1,330 grape, juice, leaf and wine samples had been analysed by the AWRI's Commercial Services. Once a result was reported, winemakers and grapegrowers were encouraged to contact the AWRI for interpretation of results and further advice. Many concerned grapegrowers and winemakers contacted the AWRI and Wine-

making and Extension Services staff responded to approximately 140 telephone and e-mail enquires during the period from mid-February to the end of April. The AWRI also provided and received smoke taint information internationally; we continue to receive many calls from California, and a number from South Africa following fires in the Stellenbosch region in March.

A great deal of information was also disseminated via the AWRI website, including general information on smoke taint, details on the process involved in having grapes, musts and wines analysed, and retrieval of articles. The key information outputs relating to smoke taint that were added to the website placed smoke taint information within the top three of the most popular areas of the AWRI website.

The AWRI also initiated a grape sampling and analysis program with the aim to better understand the impact of smoke and how it effects the concentration of guaiacol in different varieties. During the period from the end of February to the beginning of April, 74 grape and 68 leaf samples, which were obtained from five different varieties situated in three different vineyards, were analysed for the concentration of (free) guaiacol.

The data for the concentration of guaiacol in grapes seem to suggest that Pinot Noir and Cabernet Sauvignon were the most effected by guaiacol and that Sauvignon Blanc was the least affected. It is interesting that Cabernet Sauvignon and Pinot Noir were also the varieties most affected from the 2007 bushfires, with Shiraz possibly the least affected. However, winemakers who have made wines from smoke affected grapes have indicated that Pinot Noir and Chardonnay wines are the most affected and Cabernet Sauvignon was less affected. This apparent anomaly could be explained if Chardonnay grapes contain higher concentrations of guaiacol-bound glycosides than Cabernet Sauvignon grapes, for example, which could be released during fermentation, resulting in a higher

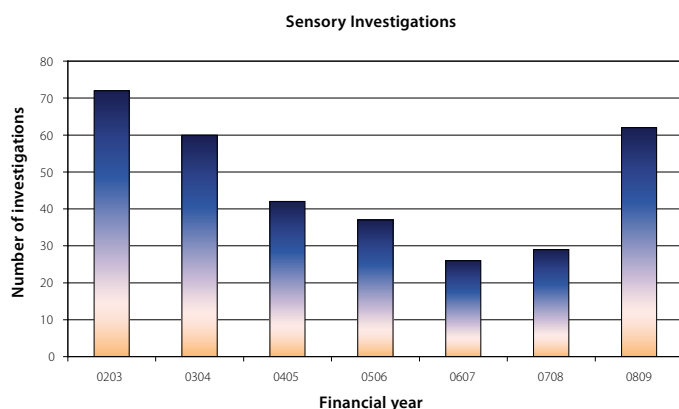


Figure 11. The number of investigations conducted into wines with sensory problems during the period 2002/2003 to 2008/2009

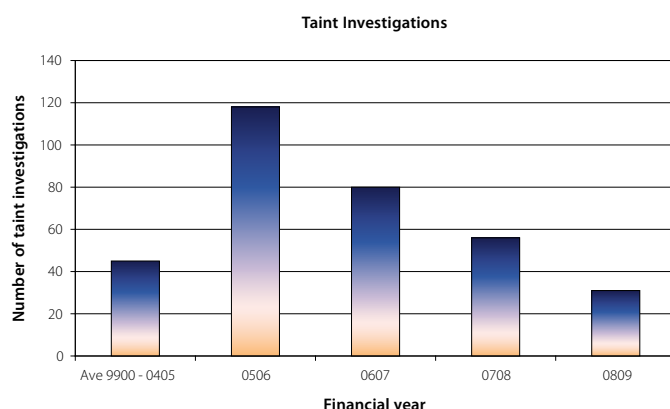


Figure 12. The number of investigations conducted into wines affected by taints during the period 2005/2006 to 2008/2009 and the average number of these types of investigations for the period 1999/2000 to 2004/2005



Team reports

level of guaiacol being observed than might have been expected based on analysis of the fruit. However, another explanation could be that smoke-related volatile organic compounds other than guaiacol might have a greater sensory effect on the perception of smoke taint than guaiacol. The release of free guaiacol from guaiacol-bound glycosides (guaiacol precursors) during fermentation and storage is now being investigated, as is the identification of any other precursors of smoke taint, with the aim to establish a method for estimating the potential of grapes or wine to develop smoke taint characters over time.

The data for the concentration of guaiacol in leaves suggests that Chardonnay and Shiraz were the most affected and that Sauvignon Blanc was the least affected. Apart from the Sauvignon Blanc variety, the concentrations of guaiacol in leaves were typically much higher than the corresponding concentrations in grapes. This emphasises the need to exclude leaves as much as possible during harvesting and crushing in order to minimise the extraction of smoke compounds into the final wine.

The AWRI's Research and Winemaking and Extension Services teams have initiated a research program in conjunction with the University of Adelaide. As part of this program, more than 100 micro-fermentations are planned using grapes exposed to smoke from the 2009 Victorian bushfires. This experiment will allow us to understand the relationship between free guaiacol and other smoke-related volatile organic compounds in grapes and wine. By conducting winemaking trials, the project will also allow us to evaluate the ability of selected winemaking practices and additives to mitigate the effects of smoke taint.

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(L to R) Brooke Travis, Leigh Francis, Patricia Osidacz and Belinda Bramley





Theme 3 Wine in society

Wine quality and consumer needs

Staff

Dr Leigh Francis, Brooke Travis, Patricia Osidacz, Belinda Bramley

Collaborators

Ehrenberg-Bass Institute for Marketing Science, University of South Australia (Professor Larry Lockshin and Dr Simone Mueller)

Sensory science provides the important link between the consumer and the complex chemical and microbiological data gathered as part of the AWRI studies. Sensory data give vital information about wine quality, whether through sensory profiles of wines, information obtained from winemaker or highly technically trained panels, or arguably most importantly, from consumers themselves.

The sensory and consumer science research team works with all groups at the AWRI and generates objective, reproducible sensory data using highly controlled procedures and sophisticated study designs. With the move during the year to the Wine Innovation Central Building we have a more efficient and modern sensory laboratory with greater capacity and greatly improved flexibility.

Numerous sensory studies have been completed by the sensory team, and results are reported elsewhere in this report. These have included projects investigating: coinoculated and single strain yeast effects on Sauvignon Blanc and also Chardonnay wine flavour; malolactic bacterial strain differences in Cabernet Sauvignon; the effect of closures and copper fining on sensory properties of Sauvignon Blanc after storage in-bottle; the influence of nitrogen supplementation – both in the vineyard and in fermentation – on Shiraz wine sensory properties; skin contact in Riesling; phenolics-related flavour effects on white wine and consumer response; and an aroma threshold study on hydrogen sulfide in red and white wines. In addition, two sensory/chemical studies were conducted assessing wines deemed, by wine show judges, to have various faults, including a set involving reductive, sulfur compound-related flavour in white and red wines. The sensory team has also worked with the Industry Applications group to quantify sensory attributes of a varied set of Pinot Gris and Pinot Grigio wines. Two studies have been completed to assess the perseverance of yeast strain flavour differences in Sauvignon Blanc wines after more than three years in-bottle. An important large study was also completed with the Industry Development and Support (IDS) group on the change in salty taste and other sensory properties as a result of differences in sodium, potassium and chloride levels in red wines.

We have supervised and coordinated the AWRI technical quality panel which has assessed an impressive 383 wines over the year, mainly for IDS and Commercial Services clients. This has been an increase of more than 30% compared to the 2007-2008 period. The assessments have included investigations of sets of bottled wines for the incidence of off-flavours and taints, as well as technical assessment of individual wines for suspected faults.

In addition, numerous difference tests have also been completed as part of projects investigating issues such as effect of packaging or storage variables on sensory properties. To continue to improve our capabilities for sensory tests, a study was completed comparing the well established 'triangle and duo-trio tests' with a somewhat simpler, potentially more time-effective methodology known as 'difference from control'. This procedure allows a greater number of samples to be assessed in a shorter period compared to other difference test procedures. However, upon evaluation, it was found that the 'difference from control' method generally was not as sensitive as the other tests in detecting smaller sensory differences.

A major project conducted in collaboration with Commercial Services has involved the final two testing periods of a closure trial assessing a Semillon wine bottled with numerous closures, including three reference closures. The 18 and 24 months' post-bottling testing times were completed. The data have shown that the reference screw-cap closure had retained a high level of fresh fruit related flavour, but had also developed a moderate 'struck flint' aroma and flavour; while the reference synthetic and reference 2 natural cork were rated by the sensory panel as less intense in fresh fruit attributes and higher in oxidised aroma. Chemical analyses revealed that the screw-cap had retained the most sulfur dioxide of the reference closures, but had an elevated level of methane thiol.

Wines bottled under the different closures were presented to consumers for assessment of overall liking. A substantial proportion of the consumers – 27% of the sample tested – responded negatively to the wines with the highest oxidised flavour; the presence of TCA, even at trace levels of 1-2 ng/L; as well as the wine with a cabbagey and struck flint aroma. A further group of consumers – 40% – were not so concerned about the presence of TCA or oxidised flavour, but did not rate the wines with struck flint aroma highly. The study showed clearly that the presence of even low level oxidation, TCA or reductive flavour can strongly influence consumers.

A collaborative consumer project with Professor Larry Lockshin and Dr Simone Mueller of the University of South Australia's Ehrenberg-Bass Institute for Marketing Science has involved a set of more than 200 international commercial red wines – including Australian wines – sourced from the US market with known sales figures.



Team reports

The wines were analysed for numerous quality-related chemical measures, and assessed informally by a small sensory panel from the AWRI. This study will provide insight into what levels of chemical constituents such as oak flavour, tannin, *Brettanomyces/Dekkera*-related flavour, alcohol, and acid are present in wines in US markets and whether these might be related to sales.

A major effort over the last year has involved completion of a red wine consumer study designed to determine Chinese consumers wine preferences. This was a project conducted by the AWRI with Tragon, a California-based sensory research company. Red wines were selected to cover major wine types produced in Australia and internationally.

Fourteen red wines were assessed by 310 Beijing, Shanghai and Guangzhou consumers, and 216 Sydney and Melbourne consumers also tasted twelve of these wines. The wines were characterised by a trained panel from the AWRI using consumer-based language, and extensive chemical compositional data were also collected on these wines.

The data obtained showed that Australian red wines were generally very well liked by Chinese consumers. The Chinese consumers could be divided into distinct preference groups. The preferences of the largest group of consumers, 50% of the sample, were driven by lighter red fruit flavour, dark colour and sweetness (Figure 13), while these consumers were negatively affected by wines with higher alcohol and (ripe) dark fruit flavour. A further 30% appreciated wines with vanilla, floral and red berry flavours, with sweetness also being a factor. They did not appreciate the presence of stronger acidity, bitterness or oxidative flavour. The smallest group of consumers, 20% of the total, preferred the dark fruit flavoured wines with higher alcohol and responded negatively if wines had elevated acid or bitter, astringent taste or were showing oxidative flavours.

The Australian consumers in many ways responded similarly, but there were some marked differences between the consumers of the two countries, especially in the proportion of consumers in the different clusters. The percentage of the Australians in the group identified as preferring lower flavoured, sweeter wines was only 38%, compared to 50% of the Chinese, while 62% of the Australians appreciated stronger flavoured wines with dark fruit and higher alcohol.

The study provided highly informative, detailed information about the differences between Chinese and Australian consumers, including a major addition to the previously scarce data on consumers' wine buying and drinking habits and attitudes to wine. Given the increasing importance of the Chinese market to Australian wine exporters, with China currently the fourth most important

export country in value, the study has given producers a wealth of information to help them optimise their efforts in this emerging market.

Human health, nutrition and food safety issues impacting on the Australian wine sector

Staff

Creina Stockley

One of the activities of the AWRI has been to provide health and nutritional advice and assistance to the Australian wine sector, through Creina Stockley, the Health and Regulatory Information Manager. From 1 July 2008 until 30 June 2009, 85 independent information health and nutrition requests were received by the Health and Regulatory Information Manager from industry, the general public and government.

Committee membership

During the year, support to the sector has been derived from the Health and Regulatory Information Manager's membership of the following industry committees: the National Drug and Alcohol Research Centre's Young People and Alcohol Project Advisory Group on behalf of the Winemakers' Federation of Australia (WFA) and the WFA Wine and Social Responsibility Committee. She is also the Department of Agriculture, Forestry and Fisheries (DAFF) nominated Australian delegate for Organisation International de la Vigne et du Vin (OIV) Health and Safety Commission (IV), and is currently the President of the Food Safety Expert Group. She is also a member of the honorary editorial board of the *International Journal of Wine Research* (Dove Medical Press). Nine media interviews were conducted including one for the Channel 9 *Sunrise Breakfast Program* which aired on 15 October 2008.

Health and nutrition issues

During the year, the database of research on the beneficial and detrimental health effects of alcohol and in particular, wine, has been added to and these records are available online for levypaying members of the Australian grape and wine sector. This is facilitated by the subscription to relevant medical and scientific journals, and by the formal and informal exchange of information between complementary organisations, both national and international. The journals have been regularly scanned, and articles have been prepared for inclusion in the AWRI's publication, *Technical Review*, and for other Australian wine sector and international alcohol industry newsletters. Articles and other material have also been prepared for the electronic and print media (see Appendix 5). For example, one article has been prepared for the monthly *Australian and New Zealand Grapegrower and Winemaker*, two articles for monthly publication *Australian New Zealand Wine Industry Journal*, including the AWRI Report and two articles for the bimonthly *Technical Review*, as well as peer-reviewed papers for *Contemporary Drug Problems: an interdisciplinary quarterly* and the *International Journal of Wine Research*. In addition, the AWRI publication *The A-Z of information on wine and health issues* has been updated.

The Health and Regulatory Information Manager also prepared a 37-page submission to the National Health Preventative Task Force, and additionally acted as a consultant for the submission of the Winemakers' Federation of Australia, as well as a 6-page submission to the World Health Organisation public hearing on ways of reducing the harmful use of alcohol. She also acted as a consultation for the Winemakers' Federation of Australia presentation and subsequent submission to the *Australia's Future Tax System Review*. In addition, she was invited to be an external peer reviewer for Food Standards

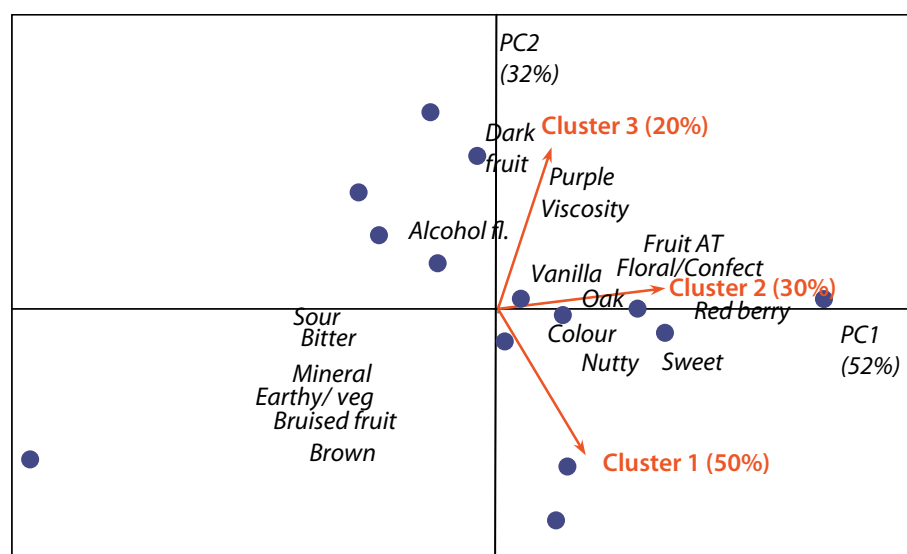


Figure 13. Preference map of the Chinese consumers' liking data for the 14 wines for the three identified clusters, with sensory attribute data obtained for the wines superimposed





Mark Braybrook (L), Jeff Eglinton (R)

Australia New Zealand (FSANZ) for Report (#1) Alcohol Warning Labels: The evidence for effectiveness in relation to excessive alcohol consumption relating to risk in the short term, and Report (#2) Alcohol Warning Labels: Evidence of impact on alcohol consumption amongst women of child-bearing age and during pregnancy, which were prepared for FSANZ by the National Drug Research Institute (Curtin University of Technology), in collaboration with Drug and Alcohol Office (WA), National Drug and Alcohol Research Centre (University of New South Wales), Public Health Advocacy Institute.

Invited presentations were made at the Rutherglen Wine Show 21st Annual Seminar on 25 September 2008, the Pernod Ricard Research Centre, in Paris, France on 20 October 2008, INRA in Bordeaux, France on 17 March 2008 and the Royal Australian and New Zealand College of Psychiatrists 2009 Congress on the 26 May 2009, and two were made at the Organisation de la Vigne et du Vin (OIV) Commission IV Expert Group meetings in Paris, France on 12-13 March 2008.

In addition, the Health and Regulatory Information Manager has continued her part-time external PhD program in the Faculty of Health Sciences at Flinders University entitled *It is not per capita alcohol consumption that matters but per occasion alcohol consumption*.

Health and nutrition issues

Project coordination

The project application #544307 Resveratrol in the chemoprevention of colorectal neoplasia was successful in securing full funding for \$575,000 over three years from Cancer Australia on 4 December 2008. Professor Finlay Macrae Head of the Department of Colorectal Medicine and Genetics at The Royal Melbourne Hospital and the AWRI's Health and Regulatory Information Manager, are the Co-Chief Investigators of the project. The project will investigate whether grape-derived resveratrol, administered in a moderate amount of red wine, reduces the risk of developing bowel cancer in human subjects. The effect of resveratrol on proteins and cell mechanisms involved in controlling cell growth and thus cancer potential will be measured from blood samples and from tissue samples taken from the bowel.

Compilation, interpretation and communication of issues pertaining to responsible use of agrochemicals in Australian viticulture

Staff

Dr Sally-Jean Bell, Marcel Essling

Eleven thousand copies of the AWRI publication 'Agrochemicals registered for use in Australian viticulture 2009/2010' have been produced and the booklet can be downloaded from the AWRI website. The booklet was also distributed with the Annual Technical issue of the *Australian New Zealand Grapegrower and Winemaker*. The agrochemical database update has been completed and these data are now available via the Agrochemical Online Search Facility. Work was undertaken to add further enhancements to the agrochemical database and the online search facility. The MRL database for 2009/2010 has been updated. Two new active constituents were added as well as China being added to the country list. We now have MRLs for 20 of Australia's major export markets as well as Codex and the European Union. A change in the EU Directive 396/2005 saw the implementation of many changes to the MRL lists. This change has implications for Australian exporters because there is now a final harmonisation of EU MRLs among member states. All wines produced in the 2008 vintage must not contain residues exceeding the national MRLs in place before September 2008. However, all EU countries have now adopted the EU MRLs and therefore, all wines produced in the 2009 vintage will have to meet these new standards. The Senior Viticulturist organised and ran the annual Agrochemical Industry Reference Group meeting to review and discuss changes to the agrochemical booklet and associated issues. A statement was prepared and submitted to the Australian Pesticides and Veterinary Medicines

Authority (APVMA) on behalf of the grape and wine sector with regard to the proposed registration of an insecticide containing eucalyptol. Although the proposed registration does not include grapes, the risk of spray drift onto vineyards is of concern. A report was prepared on the chemical control options for six-spotted mites in grapevines for the President of the Board of Directors of the Wine Industry Association of Western Australia. Six agrochemical updates were prepared and made available to producers on the AWRI agrochemical website and via the AWRI email subscriber's service. The APVMA 'off-label' permits were regularly updated for the agrochemical website. The Senior Viticulturist and the Manager of the Trace Analysis Laboratory liaised with chemical companies with regard to potential new products, trials and data required to set or change export withholding periods (e.g. AgNova, Bayer, DuPont, and Nufarm).

Regulatory, technical and trade issues impacting on the Australian wine sector

Staff

Creina Stockley

One of the activities of the AWRI has been to provide regulatory and technical advice and assistance to the Australian wine sector, through the Managing Director, the Health and Regulatory Information Manager and the Industry Development and Support group of which the Health and Regulatory Information Manager is a member. During the year, 128 independent regulatory, science and technical-related information requests were received by the Health and Regulatory Information Manager from the wine sector, the general public and government. Three media interviews were also conducted.

Industry Committee membership

During the year, support to the wine sector has been derived from the Health and Regulatory Information Manager's membership of the WFA Wine Industry Technical Advisory Committee and the WFA Wine Industry National Environment Committee. The Health and Regulatory Information Manager was the DAFF nominated Australian delegate for the OIV Expert Group meetings.

Technical and regulatory issues

The technical and regulatory support to the Australian wine sector is ongoing as issues are regularly raised by industry or government, both in Australia and internationally, and often span several years. During 2008/2009, technical and regulatory information and/or issues that have been reviewed, and material prepared includes: the status of the concentration of ethyl carbamate in Australian grapes and wines together with the present actual and potential ethyl carbamate analyses utilised by the AWRI Trace Analysis Laboratory; the use of flour in cooperage



Team reports

and its allergenic potential; and the allergenic potential of the processing aid isinglass in wine. In addition, the Health and Regulatory Information Manager was a member of two OIV working groups — *Protocol for the evaluation of the risks related to food safety for new oenological treatments* and *Taskforce on allergens*, of which she is chair. The former encompassed preparation of a 'decision tree' and accompanying protocols for evaluation of the risks related to food safety of new oenological treatments, to facilitate the future adoption of new oenological treatments by the OIV, and by Food Standards Australia New Zealand to which the OIV is a reference body. The aim of the latter is to coordinate research for a subsequent submission to the European Food Safety Authority to provide for a permanent derogation for wine on allergen labelling for egg and milk products. Furthermore, the information in the AWRI booklet 'Analytical Specifications for the export of Australian wine' has been updated and made available on the AWRI website.



The Health and Regulatory Information Manager also coordinates Course 3005WT *Grape industry practice, policy and communication* for the School of Agriculture, Food and Wine at The University of Adelaide. In its fourteenth year, 14 students enrolled in the Course, which exposes students to organisational, commercial, environmental, political, societal and technical issues relating to the wine sector's operating environment.

Theme 4 Information and knowledge transfer

Transfer of knowledge relating to winemaking

Staff

Con Simos, Adrian Coulter, Geoff Cowey, Matt Holdstock, Emma Kennedy, Sarah Ballantine, Virginia Phillips, Peter Godden and Ella Robinson

The winemaking consultancy and technical problem solving services offered by the Winemaking and Extension Service team are supported by extension activities including a national roadshow seminar and workshop program, AWITC workshop program, the Advanced Wine Assessment Course, Research to Practice® and tailored workshops on request by sector associations. The team makes regular contributions to the *Technical Review*, provides presentations for external seminars and conferences; contributes to the web-based technical reference manual and also provides 12 hours of lectures to Oenology students at the University of Adelaide (see the Appendices for further details).

The National Roadshow seminar and workshop program are currently made on a rotating basis to 33 locations covering Australia's winemaking zones and regions. A Roadshow schedule for the next three years is available on the AWRI website which is intended to provide advance notice to regions of AWRI's impending visit. These extension activities are now advertised in the national wine press, publications of ASVO, AWBC, and NWGIC and through the local wine association websites.

During the year, 21 days of roadshow seminars and workshops were held throughout Australian winemaking zones and regions including: Griffith, Canberra, Hobart, Launceston, Wangaratta, Avoca, Bendigo, Hunter Valley, McLaren Vale, Langhorne Creek and Toowoomba.

Roadshows seminars are organised in conjunction with the regional associations for grape and wine producers. These associations select the presentations to be made from a menu of over 100 research topics covered by the AWRI, in order that the seminars are closely tailored to the interests and needs of the audience. Whilst Winemaking and Extension Services team members are responsible for the organisation of roadshows and present a substantial amount of the content during the seminars, they rely heavily on input from all of the AWRI's teams with at least five staff members making nine presentations in each full-day seminar. One of the latest initiatives is the introduction of an interactive session, this enables the participants to discuss in an open forum, issues and challenges that are relevant to their particular region.

Roadshow workshops are generally presented solely by Winemaking and Extension Services team members, and are tailored to deliver practical winemaking advice to the wine sector in an interactive manner involving tastings; diagnostic tests and practical exercises. These workshops are developed specifically to manage current technical issues. The current workshop presented is entitled 'The avoidance of taints and chemical instabilities during winemaking' and was developed to educate and inform Australian wine producers of taints that have affected the wine sector in recent times. New material has been developed for a workshop detailing practical and trouble-free wine bottling and packaging.

New workshop material is often prepared at the specific request of associations in order to accommodate their needs. During the year, Winemaking and Extension Services team members responded to requests from regional associations on presenting dedicated content. This included development of material on the 2008 heat wave and associated stuck fermentations, which was delivered in the Clare Valley and McLaren Vale, and development of material on the 2009 bushfires in Victoria, which was presented in the Yarra Valley in May. Other material that was presented on request included 'taints and faults' tastings and seminars that were presented to the UK Circle of Wine Writers; the teachers involved with the Queensland College of wine tourism 'Gateway Schools Project'; the New England Wine Show; the Melbourne Masters of wine seminar; the AWBC and Wine Australia USA wine educators; and at the Geelong Winegrowers Association wine faults workshop. In addition, staff presented seminars entitled 'Haze and sediment identification' and 'Preventing wine taints and faults' at an Interwinery Analysis Group seminar held in the Barossa Valley Convention Centre and also presented a seminar entitled '*Brettanomyces* research and practical control measures' at the Melbourne Masters of wine seminar in Melbourne.

In early 2008 the AWRI formally assumed responsibility for the 'Research to Practice®' training and education modules from the now disbanded CRC for Viticulture. In the first stage, two viticulture modules from the existing program have been updated and are due for release in August 2009. The 'Research to Practice®' model will also be expanded to address winemaking issues; the first module will address the issue of smoke taint.

The team also offers information and responds to current sector issues in publications throughout the year. The article entitled 'Don't get contaminated this vintage' was published in the February issue of *Technical Review* (#178) and an article on the same theme entitled 'Brines, paints, oils and the occasional mobile phone – common vintage contaminants' was published in the *Australian & New Zealand Grapegrower & Winemaker* (#541), in response to an increase in paint tainted wines during the 2008 vintage.

Further to the heatwave conditions which were experienced during vintage 2008, two articles detailing the increase in stuck fermentations and management strategies were also prepared. One of the articles titled 'Vintage 2008 – A heat wave and stuck fermentations' was published in the August edition of *Technical Review* (#175), whilst the other was titled 'When the heat is on, yeast fermentation runs out of puff' and was published in the *Australian & New Zealand Wine Industry Journal* (#23/5).

The delivery of the Advanced Wine Assessment Course (AWAC) continues to be an important service offered to those who seek to expand their knowledge in wine show judging and improve their sensory skills. The AWRI remains committed to expanding its AWAC program, and in the period since November 2006, eight AWACs have been successfully staged.

The 26th AWAC and the first to be scheduled outside Adelaide was held at the Lilydale campus of Swinburne University in September. Despite the many challenges of operating in a new environment, the course was rated a great success by the participants. The level of organisation and the planning made to get the logistics right ensured the whole course went efficiently. A number of comments were also made by the respondents praising the AWRI's commitment to staging the event in Victoria. Gratitude is also expressed to those Victorian wine sector stakeholders who supported the staging of this event.

The 27th AWAC was held in November in Adelaide. Both courses provided a further 60 participants the opportunity to develop and test their sensory evaluation performance. The first AWAC was held in 1992; since that time over 840 participants have completed the course. Currently these courses are presented as a four-day format and, as part of the intensive program, potential judges have the opportunity to evaluate a diverse range of more than 316 wines under simulated wine show conditions. The course consists of more than 40 hours of content and also includes lectures presented by staff from the AWRI and the participation of 14 leading wine show judges, journalists and wine-makers. The top performing participant from each course now has the opportunity to participate as an associate judge at a national wine show level; normally it can take years for AWAC graduates to judge at this level. The dux program recognises and creates an opportunity for those who aspire to judge at the highest levels.

In collaboration with Wine Australia, the AWAC model was presented as a one day seminar to key members of the Irish wine trade in Dublin in January. The objective of this event was to illustrate AWRI's role within the Australian wine sector and how its research outcomes are a major contributor to wine sector innovation and quality assurance. The presentation consisted of a flavour, taints and faults tasting followed by an abridged version which

highlights core elements of the AWAC. This event was extremely successful, with Wine Australia requesting a repeat event in London. This event was scheduled in June and attended by some of the UK's most prominent journalists, wine-buyers and educators. The event again proved to be an outstanding success. A further event is also currently being planned for Hong Kong in September followed by a flavours, faults and taints tasting in Shanghai. The AWAC team also hosted the participants of Landmark Australia tutorial.

The Industry support section of the AWRI website is a primary source of winemaking and technical information to Australian wine producers. The quality of the information on the website replaces the majority of written reports previously prepared for wine sector clients by the Winemaking and Extension Services team. This part of the website received a total of 97,537 hits this year, reporting an increase of 17% from the previous financial year. The winemaking and extension section of the website now receives 39,587 of these hits, reporting an increase of 37% from the previous financial year.

The significant increase of website hits is largely due to the quality of information and an annual program of reviewing and introducing new and interactive content. In the last year some of the following new features have been added:

- » A new 'winemaking and extension' services homepage, to better direct winemakers to content.
- » A frequently asked question (FAQ) section.
- » The sensory section was updated to include the latest Brett sensory threshold data.
- » A new acidity conversions calculator was created allowing acidity to be converted and expressed as sulfuric acid for exporting requirements, as well as comparing citric acid to tartaric acid equivalents.
- » The Grape Juice Concentrate (GJC) calculator was modified to include instructions on the calculation of GJC in Brix to g/L.
- » A 'yeast hulls' screening procedure was added to the screening tests for commonly used winemaking chemicals and processing aids.
- » A new FAQ entitled 'Where can I find more information about heatwaves and subsequent effects on fermentation' was added.
- » A stuck fermentation fact sheet, the method for preventing and managing stuck ferments, and a paper about the 2008 heatwave and stuck fermentations were linked as answers to a new FAQ entitled 'Where can I find more information about stuck alcoholic fermentations'.

» A FAQ section regarding smoke taint advice and information.

» A document entitled 'Fining agents' was prepared and subsequently uploaded to the AWRI website as additional information for the FAQ section.

The AWRI and Industry events calendar has been updated to include other non-AWRI industry events such as ASVO conferences, as well as details of dates for the next 12 months roadshow seminars, workshops and AWACs. Links to the relevant wine-making associations hosting each roadshow are also included on the events calendar as are Google map links to guide attendees to roadshow locations.

The IDS team has also added two further AWRI webcast presentations titled 'Heat waves, drought and stuck fermentations' and 'Haze and sediment identification'.

Transfer of knowledge relating to viticulture

Staff

Dr Sally-Jean Bell, Dr Peter Dry, Marcel Essling

During 2008/2009 the viticultural team responded to 320 viticulture-related enquiries. The majority related to the use of agrochemicals for pest and disease control; the persistence of residues through winemaking and their effects on fermentation; and issues related to maximum residue limits in overseas markets.

Other issues of note that were dealt with include a fruit fly outbreak in Hunter Valley, apple looper outbreak in Margaret River, heat stressed vines, salty and sodic soils and varietal identification. The viticulture team participated in the AWRI Roadshows throughout the year (see Appendices for further details). In addition, a pilot AWRI Viticulture Roadshow was held in the Limestone Coast.

Details of seminars attended during the year are shown in Table 3.

The Senior Viticulturist gave presentations entitled 'Can vine and wine nutrient status affect wine quality?' at a McLaren Vale Winemakers seminar (11/09/08); 'Best Management for Nitrogen Fertilisers' at the Yalumba Growers Seminar on (30/09/08) and 'Agrochemical issues and major changes to the 2009/2010 Agrochemical booklet' at an IHD Vitilink Agronomy Forum (26/05/09) (see Appendices for further details).

The Technical Officer – Viticulture attended the GWRDC Innovators Network 'Water & Vine' workshops in Rutherglen, Langhorne Creek and Glen Osmond and a 'Vintage Update' meeting in McLaren Vale convened to address issues raised by the prolonged heat-wave (04/02/09). Also during the year, the Technical Officer – Viticulture undertook work experience at Geisenheim Research Centre



Team reports

Table 3. Seminars/workshops attended by Viticulture team members during 2008/2009

Seminar/workshop	Date	Senior Viticulturist	Technical Officer – Viticulture
Rootstocks for a changing environment in the Barossa	23/07/08	✓	✓
Grape genetics and rootstock breeding update from UC Davis at Banrock Station	25/07/09	✓	✓
GWRDC 'Water & Vine' workshop	18/03/09	✓	✓
ASVO seminar: Breaking the mould – a pest and disease update	24/07/09	✓	✓
ASVO seminar: Footprints, food miles and furbies	10/09/09	✓	
Eighth International Symposium on Grapevine Physiology and Biotechnology	24-25/11/08	✓	✓
Bayer Pest and Disease Seminar	22/7/08	✓	

working with Dr Manfred Stoll. Plant water relations and the use of thermal imagery to measure water stress was the primary focus of the research. Together with the Viticulture Consultant, Research to Practice® training modules were developed to help growers cope with climate change and addressed grapevine nutrition and integrated pest management. Materials relating to the major pest and disease issues facing the viticulture sector as well as information pertaining to vine physiology were updated from CRCV Viti-Notes.

The Viticulture Consultant commenced employment in November 2008. He was a keynote speaker at the Eighth International Symposium on Grapevine Physiology and Biotechnology (24-25/11/08). For the AWRI roadshows, he prepared 12 new presentations including three based on material from the GWRDC 'Water & Vine' series, and also recorded a webcast on 'Vine balance'. He participated in every roadshow from November 2008 and delivered 24% of all presentations.

Communication and Information Services

Staff

Con Simos, Rae Blair, Linda Bevin (returned from Maternity Leave 20 April 2009), Leanne Curtin (until 12 December 2008), Kate Beames, Sean Boden, Anne Lord (from 27 August 2008), Ingrid Barratt (maternity leave from 22 August 2008), Claire St George, Fiona Taylor

The CIS team is a service unit within the AWRI and forms part of the Industry Development and Support group, led by Con Simos. The CIS team is responsible for the strategic sourcing of relevant technical information and, in collaboration with our stakeholders, for its effective delivery to Australian grape and wine producers of all sizes.

All of our activities are benchmarked against our team's vision and mission¹, the AWRI's Business Plan² and the AWRI's 7 year Research, Development and Extension Plan³. The operations of the CIS team also complement and support the knowledge management and communication activities of all of the AWRI staff.

The team

The team comprises the Communication Manager (Rae Blair; .4 FTE), the Information and Knowledge Manager (Linda Bevin; .6 FTE), Systems Librarian (Sean Boden), Library Technician (Ingrid Barratt, Maternity Leave from 22 August 2008; her position filled by Anne Lord), Communication Assistant (Kate Beames; .4 FTE) and part-time Library Assistants (Claire St George and Fiona Taylor).

Highlights and activity

Our specific activities include the following:

- » Corporate communication and brand management (facilitating effective communication between the AWRI and its stakeholders);
- » Information and knowledge management;
- » Maintaining the collection held within the John Fornachon Memorial Library;
- » Management of the AWRI website, and web-accessible information databases;
- » Production of corporate publications, including *Technical Review* and the Annual Report;
- » Provision of an editorial service for the staff of the AWRI; and
- » Media and VIP visit coordination.

Progress reports on our GWRDC-funded activities are shown below. However, some of the highlights for the 2008/2009 financial year include:

- » Establishment of the AWRI's Information Resources facility within the new Wine Innovation Central Building (increased usage and improved management of resources);
- » Management of a 27% increase in information requests – over 4,800 enquiries were responded to during the year;
- » Increased usage and improved management of Information Resources: an extremely strong year was recorded in delivering information solutions to customers in-house and within the grape and wine sector. In particular, a 73% increase was recorded for documents forwarded to customers;
- » Migration of the AWRI Online Image Collection to an in-house developed system, thus significantly reducing operating costs of the system and improving administrative control;
- » Significant maintenance and new visual template applied to the AWRI website: content of the website is easier to access and more relevant for visitors. New content included nine additional webcasts of presentations given by staff from the AWRI; additional information from the Research group, as well as new applications for the Wine & Health and Regulatory Information sections of the website;
- » A collaboration portal (internally known as WiSE 'Wine Information for Scientific Endeavors') developed using Microsoft SharePoint 2007 was successfully piloted;
- » A new corporate brochure, and three versions of a corporate video for the AWRI were produced: assists our stakeholders to gain a better understanding of their actual or potential return on investment in the AWRI's activities;
- » Sixteen 'fact sheets' were prepared to more fully inform the AWRI staff of key business facts and management positions; and
- » Finalisation of a partnership/joint venture agreement between the AWRI and the Institute of Masters of Wine. This arrangement increases the AWRI (and hence the Australian grape and wine sector's) profile with key opinion leaders globally.

¹ See www.awri.com.au/information_services/

² See www.awri.com.au/about_us/business_plan/

³ See www.awri.com.au/research_and_development/rdec/7_Yr_RDE_Plan_Executive_Summary.pdf

Provision and development of mechanisms for the efficient transfer of knowledge and technical information to the Australian grape and wine sector

Staff

Rae Blair, Sean Boden, Kate Beames

The AWRI utilises several strategic and effective mechanisms to disseminate knowledge and information to Australian grape and wine producers. Reported above are the physical extension activities – the body contact sport – undertaken by the other members of the Industry Development and Support group. Below are details of the less direct, or personal, extension/communication mechanisms, but nonetheless deliver information to the vast majority of our stakeholders.

An annual report to grape and wine producers

The end of the financial year gives us a formal opportunity to collate and review our activities during the year. Apart from this printed annual report, the AWRI takes the opportunity to give a personal annual report to the peak producer bodies in each State. At these presentations, we present key research outcomes and activities during the year that are of the most interest to each group. We also published an 'annual review' of our activities as a four-page supplement in the *Australian & New Zealand Grapegrower & Winemaker*, which appeared in the November 2008 issue.

AWRI website

We recognise that the effectiveness and true value of the AWRI website, as an information resource, comes if the information is relevant, easy to find and current. We again undertook significant maintenance of the AWRI website over the past 12 months with the Systems Librarian liaising with various senior members of staff to restructure the content. As part of the project, the website was given a new visual template to align it with the new corporate branding introduced in late-2008 and various applications and enhancements. The refreshed website was made live on 30 June, and featured a great deal of additional content from the Research group, as well as new applications for the Wine and Health and Regulatory Information sections of the website.

It is expected that following the re-structure, the AWRI website will also be in a better position to increase the wealth of information available in an easier-to-access format as time goes on.

Compared to the previous financial year, the website recorded a 1.29% decrease in pages viewed during the course of the financial year (Table 4 and Figure 14). This slight decrease can be attributed to the lack of significant updates in the second half of the financial year due to content being held back for inclusion in the launch of the updated AWRI website.

Table 4. Website statistics 1 July to 30 June

	2008	2009	% change
Pageviews	353,165	348,608	-1.29%

Technical Review

Technical Review is a bimonthly publication produced by the AWRI and provides progress reports to producers on the AWRI's research, as well as updates on relevant conferences, regulatory amendments and medical issues. The 'Current Literature' section provides citation details and abstracts of recently published technical and scientific articles. During the year, the front cover underwent a new design to align it more closely with the AWRI's new corporate branding.

In the financial year of 2008/2009, more than 18,000 copies of *Technical Review* were distributed to Australian grapegrowers and winemakers who pay the *Grape Research Levy* or *Winegrapes Levy* and subscribers in Australia and overseas. Over 400 articles featured in *Technical Review* were requested and forwarded (25% increase over last year).

All copies of *Technical Review* are made available via the AWRI website, and a more effective search capability of articles appearing in *Technical Review* was implemented.

Dr Barbara Hardy AO and her family continue to support the publication of *Technical Review* through regular generous financial contribution to the Thomas Walter Hardy Memorial Trust, and their ongoing support is gratefully acknowledged.



Peter Dry and Linda Bevin

Email service

The Email Advice and Information on Technical Issues Bulletin service continues to be a fast and cost-efficient way of disseminating important technical information to interested members of the Australian grape and wine sector. There are >3,500 email addresses recorded to receive the email bulletins, and interested Australian producers should submit their email address (to infoservices@awri.com.au) should they wish to receive the email bulletins. Sixteen email bulletins were issued during the year and are shown in Table 5.

Editorial services

The Australian Wine Research Institute contributes a regular column in the *Australia and New Zealand Wine Industry Journal* and continues to publish in the *Australian and New Zealand Grapegrower & Winemaker* and Australia's *WBM* amongst other Australian and international industry journals. All papers authored by the AWRI staff, to be published in non-peer reviewed publications, are edited by the Communication Manager (details of the articles published are in Appendix 5). The Communication Manager also reviews all material to be uploaded to the AWRI website.



Figure 14. Website pageviews for 1 July 2008 – 30 June 2009



Team reports

Table 5. Email bulletins sent during 2008/2009

Date	Email	Author
9/7/08	Agricultural Update July 2008: The AWRI publication <i>Agrochemicals registered for use in Australian viticulture 2008/2009</i> is now available. Major changes in the 2008/2009 Dog Book	Sally-Jean Bell
29/7/08	APVMA 61873 – Green Seal	Sally-Jean Bell
16/9/08	Agrochemical update	Sally-Jean Bell
8/10/08	Australian wine researchers first to crack the code	Rae Blair
9/10/08	Agrochemical update	Sally-Jean Bell
22/10/08	Improved grape and wine information database now available	Sean Boden
27/10/08	AWRI survey opens the door to China for Australian winemakers	Rae Blair
1/12/08	AWRI's 2008 annual report now available online	Rae Blair
17/12/08	Fact sheet on stuck fermentation now on AWRI website	Rae Blair
5/1/09	AWRI and Royal Adelaide Wine Show announce Dux of AWAC course	Rae Blair
6/2/09	AWRI bulletin: The 2009 heatwave and effects on vines	Winemaking Services team
27/2/09	AWRI bulletin: Information for grape and wine producers concerned with smoke taint	Rae Blair
5/3/09	AWRI announces appointment of Dr John Stocker AO as Chair	Rae Blair
16/3/09	Agrochemical update	Sally-Jean Bell
2/6/09	AWRI bulletin: Isinglass exemption for wine label gazetted	Creina Stockley
22/6/09	Changes in the 2009/2010 Agrochemicals registered for use in Australian viticulture	Sally-Jean Bell

During the year, the Communication Manager also edited several 'Fact sheets' about different aspects of the AWRI – which have been subsequently made available via the AWRI website. Other communication pieces were also edited, such as an information card on the services available from the Winemaking and Extension Services team; promotional leaflet on the AWRI's Wine Microorganism Culture Collection service; and poster showing common wine microorganisms.

Provision of scientific, technical and regulatory information

Staff

Linda Bevin (returned from Maternity Leave 20 April 2009), Leanne Curtin (until 12 December 2008), Sean Boden, Anne Lord (from 27 August 2008), Ingrid Barratt (maternity leave from 22 August 2008), Claire St George, Fiona Taylor

The John Fornachon Memorial Library

The John Fornachon Memorial Library holds the largest collection of grape and wine technical literature in the Southern Hemisphere, covering winemaking, viticulture, wine microbiology, flavour chemistry, phenolics, food chemistry, wine and health, wine and the environment, and more. The collection includes books, journals, article reprints, conference proceedings, reports, theses, standards and legislations, as well as a reference collection of foreign dictionaries and atlases.

With the AWRI's move into the new Wine Innovation Cluster Central Building, the Library has been integrated as a core feature of the new facilities. The move has seen usage of the physical collection increase, and has also presented the opportunity for the Library to take significant stock of the collection and incorporate various materials previously held elsewhere in the AWRI, effectively centralising them within the Library. The combination of these factors has consequently seen significant maintenance to the Library's primary catalogue during this period. See Table 6 for a list of statistics regarding the information databases.

The AWRI has an ever-growing knowledge base, and technology is providing opportunities for the John Fornachon Memorial Library to evolve beyond the traditional concept of libraries and focus on the expansion of electronic information access and delivery. Printed publications will continue to be an important part of our collection, but a 'modernisation' program is underway to ensure our information services continue to be of value and relevance to our customers.

Online information databases

Three information databases, available via the AWRI website, can be accessed by all grape and wine producers who pay the *Grape Research Levy* or *Winegrapes Levy*. The databases are a valuable information resource comprising books, journal articles, conference proceedings, reports, standards and legislation held in the AWRI collection, and users of the databases can also request items online.

The latest addition to the Library's web-accessible databases is the migration of the AWRI Online Image Collection to an in-house developed system. The move has significantly reduced operating costs of the system and allows for greater administrative control of the content. It has proved to be a popular addition to the Library's online services since its launch in early 2009, as demonstrated in Figure 15.

There is strong demand for information access via the web, which is available 24 hours a day, 7 days a week. Customers continue to show support for the *Industry* information database, which demonstrated a 74% increase in usage compared to figures reported last year. Figure 15 provides a summary of database usage during 2008/2009.

Table 6. Description and number of records of online information databases and library catalogues

Web accessible information databases	
<i>Industry</i> (with searchable abstracts)	58,934
<i>Environment</i>	2,218
<i>AWRI Online Image Collection</i>	2,338
Library catalogues databases	
<i>AWRI_database</i> (library catalogue)	61,247
<i>Journals</i> (journals, theses, statistics and annual reports)	465
<i>REGS</i> : European Community wine legislation	412
New items and maintenance to the information databases	
<i>New monographs</i>	315
<i>Theses</i>	5
<i>Record maintenance</i>	32,917
Reprint Collection to date (see below for details)	27,392
- <i>Reprints</i>	19,036
- <i>AWRI publications</i>	1146
- <i>Articles indexed via Technical Review</i>	7183

John Fornachon Memorial Library catalogue databases

The Library holds over 60,000 records of books, conference proceedings, theses and scientific, technical and medical reprint articles. They are indexed in the Library's database catalogue which is accessible via the John Fornachon Memorial Library. Details of the Library's journal holdings including newsletters, statistics and annual reports are held in the *Journals* database. A summary of the size of the Library's catalogue and information databases is given in Table 6.

Specialised information services

While the usage of the AWRI's *Industry* online information database is increasing and the database is available free of charge to all Australian grapegrowers



and winemakers who pay the *Grape Research Levy* or *Winegrapes Levy*, customers are continuing to request the Library to conduct online searches using commercial databases on a fee-for-service basis.

Document delivery services

'Document delivery' supplies journal articles, books or other library items to customers upon request via post, fax or electronically via e-mail in PDF format. This also includes sourcing items held by other Australian and overseas libraries if the requested content is not available in-house. The ability to order items online means that the majority of document requests are able to be completed within three days.

The Library has recorded an extremely strong year in delivering information solutions to customers in-house and within the grape and wine sector. In particular, a 73% increase was recorded for documents forwarded to customers during this period (this is an ongoing trend as last year saw a 62% increase in requests serviced over the year before that) (Table 7).

Copyright services

The Library continues to provide copyright advice and services within the AWRI to facilitate the best and fastest solutions possible for the AWRI staff and the grape and wine sector as a whole. During this year we have worked with publishers and copyright agencies to increase the availability of information available electronically, either via e-mail or as documents available to download via the AWRI website, and we have noted that the trend towards electronic document delivery noted last year has become the de-facto method of document delivery wherever possible.

Library collection

A total of 315 books and 5 theses were added to the collection in the financial year of 2008/2009. The Library continues to subscribe to 72 journals and receives over 70 annual reports, newsletters, journals through exchange and donation. The collection also holds over 26,000 reprints that consist of AWRI staff publications, articles featured in *Technical Review* and articles obtained via inter-library loans (Table 6).

Donations to the Library collection

The AWRI wishes to thank all individuals and companies who contribute to the collection through donations or exchange agreements. The support of the following persons and organisations who have donated books, journals or photographic material is acknowledged:

Australian Dried Fruits Corporation, Australian Wine and Brandy Corporation, Australian Wine and Brandy Producers' Association, Commonwealth Scientific and Industrial Research Organisation, Creina Stockley, and the Winemakers' Federation of Australia Incorporated.

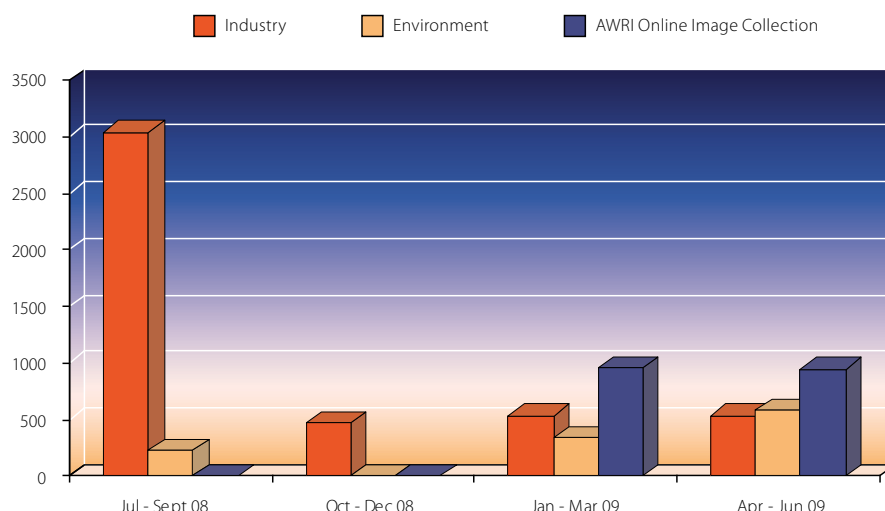


Figure 15. Summary of database usage during 2008/2009

Improvement of knowledge management, stakeholder communication and culture at The Australian Wine Research Institute

Staff

Rae Blair, Linda Bevin (returned from Maternity Leave 20 April 2009), Leanne Curtin (until December 2008)

In its 54 years of operation, the AWRI has generated substantial amounts of unique information and also enhanced the existing knowledge base of the technical aspects of wine production. A key aim of this project is to ensure our existing knowledge becomes a catalyst to more freely create new knowledge. This can only be achieved if the information and knowledge is managed to become more useful and 'user friendly' not only to Australian grape and wine producers, but also for the staff

of the AWRI. We continue to investigate and utilise new technology to fulfill our objectives. This project aims to complement the other activities of the CIS team (as reported above) and to contribute to the improvement in the brand perception of not only the AWRI but also Brand Australia to the ultimate benefit of the Australian grape and wine sector.

Information and knowledge management

A pilot of the new collaboration portal and content management system, internally known as WiSE (Wine Information for Scientific Endeavours), was successfully completed. Twenty-four staff members from across the AWRI participated in the pilot and provided valuable input into the final design and implementation approach. Further customisation is underway for a rollout date in August 2009.

Table 7. Summary of information requests during 2008/2009

	Wine industry		Staff		Other ⁵		Total		% Change 2008
	2009	2008	2009	2008	2009	2008	2009	2008	
Information requests ¹	1212	1241	930	741	633	328	2775	2310	20%
<i>Technical Review</i> requests ²							124	96	29%
<i>Technical Review</i> articles forwarded ³							429	342	25%
Articles forwarded ⁴							1171	675	73%
Number of AWRI publications forwarded							519	528	-2%

¹ Includes overall article, book and general requests, copyright advice, literature searches and website account enquiries.

² Number of requests received for articles published in *Technical Review*.

³ Number of articles forwarded (usually more than one article is requested).

⁴ Number of articles forwarded from the library collection, excluding staff publications.

⁵ Requests from students, Government agencies, private companies and overseas customers.



Team reports

Improved communication with stakeholders

To more clearly communicate the activities and benefits of the AWRI, two new communication devices were developed. The first was a new corporate brochure which was distributed to stakeholders and is made available to interested parties. The brochure elucidates the AWRI's business model and how each area contributes to the Australian grape and wine sector. The second communication device was the production of a corporate video – which has been made into three distinct videos – each edited to more closely target our key objectives. The first video runs for about 6 minutes. This version will be uploaded to the AWRI website and will also run on continuous loop during, for example, the registration phase of AWRI's Roadshows. This first version gives a good overview of the AWRI, including what it is like to work for the AWRI and the Australian wine sector, and it identifies the AWRI's value to Australian wine producers. The second video is an edited version of the 6 minute video; edited down to around 3 minutes. The focus of the second video is to attract staff to work for the AWRI. The third version is also

an edit of the first video, also runs for 3 minutes, and the focus of this version is to elucidate the benefits of the AWRI to our stakeholders.

In an endeavour to more fully inform the AWRI staff members about different aspects of the AWRI, a series of 'fact sheets' (referred to internally as Wikis) were prepared. These Wikis will be available via the AWRI's new Electronic Content Management System (AWRI's intranet) when it is up and running.

AWRI webcasts

A further nine presentations by the AWRI staff were recorded and made available via the AWRI website. Access to these webcasts is available to Australian grape and wine producers and also to staff and students from tertiary organisations offering oenology and viticulture courses. The 17 presentations available for viewing cover the following topics:

- 1 2008 the year in review
- 2 Malolactic fermentation

- 3 Pepper aroma in Shiraz
- 4 Protein haze in white wines
- 5 Defining preferences in Chinese red wine consumers
- 6 Haze and sediment identification
- 7 Texture and structure of dry white wine
- 8 Vine balance, yield and winegrape quality
- 9 Heatwaves, drought and stuck fermentation
- 10 AWRI wine bottle closure trials - towards a greater understanding of wine development in bottle
- 11 Taints and contaminants
- 12 Enhancing varietal flavour in wine
- 13 Phenolics, tannin and colour
- 14 Management of wine fermentations
- 15 Winemaking implications for the management of smoke and bushfire taints
- 16 Dekkera/Brettanomyces yeasts and 'Brett' in Australian red wine
- 17 Spectroscopy and chemometrics: rapid process monitoring tools for the wine sector

Media liaison

The AWRI is often approached for comment on wine technical matters from national and international media. We take this opportunity to ensure accurate information is published about wine made in Australia and to generate further communication opportunities with our stakeholders. Many requests from the media were handled during the year, and specific details can be found in Appendix 4. Media releases distributed during the year are shown in Table 8.

Table 8. Media releases distributed 2008/2009

Date	Details
8/10/08	Australian wine researchers first to crack the code
27/10/08	AWRI survey opens the door to China for Australian winemakers
17/11/08	AWRI establishes first node in Tasmania
5/1/09	AWRI and Royal Adelaide Wine Show announce Dux of AWAC course
5/3/09	AWRI announces new Chair
3/6/09	AWRI Roadshow in the Hunter Valley



Supporting Brand Australia

Working with Wine Australia

On Tuesday, 27 January, the AWRI teamed up with Wine Australia Ireland to host a truly unique event for 30 members of the Irish wine trade. Con Simos, Group Manager – Industry Development and Support presented a mini-Advanced Wine Assessment Course (AWAC) – the first time this course has been offered outside of Australia. The Communications Manager assisted in the presentation of the mini-AWAC. Following the response from participants, and the positive impressions generated for Brand Australia and the AWRI, a further mini-AWAC was held on 29 June at Australia House (as part of the Australian Government's week long events for *G'day UK*). Wine Australia UK organised another 30 key wine writers, buyers, consultants and educators to attend the course, and again an overwhelmingly positive response was achieved. Following this event, the Group Manager – Industry Development and Support returned to Ireland and held a 'Wine taints and faults' workshop with a further 30 key wine trade participants.

Working with Austrade and Wine Australia

The Communication Manager and the Group Manager – Industry Development and Support finalised an agreement for the AWRI to provide the mini-AWAC in Hong Kong and a 'Wine taints and faults' workshop in Shanghai in September 2009. This activity, funded from an external source, will be held under the auspices of Wine Australia and Austrade.

Institute of Masters of Wine

It is generally considered that wine professionals who graduate from the Institute of Masters of Wine program become opinion leaders globally. We believe it is in the best interests of our industry that these leaders have an understanding of the unique support of science and quality assurance behind Australian wine production. To this end, the AWRI approached the Institute of Masters of Wine and subsequently a joint venture agreement has been completed (a press release was distributed early in July 2009). The arrangement in place provides for the AWRI to assist the IMW in hosting its Australasian seminar annually, and the AWRI provides one place in our four-day Advanced Wine Assessment Course to an IMW member. The AWRI will also be given space on the IMW seminar program in the US or in Europe to conduct selected themed tastings highlighting AWRI's research work and the benefits to the Australian wine sector. The agreement runs for three years, with an annual review, and with the intention for the agreement to be ongoing.

Commercial Services

Staff:

Dr Vince O'Brien, Leanne Craddock, Randell Taylor, Warren Roget, Simon Odell, Oliver Lovat, Jean Macintyre, Teegan Schurgott, Jelena Jovanovic, Alana Williams (Maternity Leave from 13/04/2009), Andrea Francis, David Boehm, Heather Brooks, Slavko Bekavac, Yvonne Staeffler, Daniel Tynan, Pamela Stepancich, Timothy Reilly, Carlo Congiusta

The AWRI Commercial Services financial performance was solid in the 2008/2009 financial year underpinned by encouraging uptake of our improved range of support services for our customers. We successfully negotiated moving premises to our new state-of-the-art facility and still maintained above budgeted performance injecting the surplus revenue gained into AWRI's industry support capabilities. We have worked extremely hard to build our capabilities to provide cost-competitive high-utility support services to our customers and this will continue to be our focus over the next financial year.

Our improved services have a single aim: to provide high quality, technically robust support tools for Australian producers, which helps them stay competitive in increasingly challenging economic and environmental conditions.

Some of the progress highlights include:

- » our packaging assessment capability;
- » our technology benchmarking service; and
- » novel analytical technologies.

A brief overview of our highlights and some of these new capabilities are outlined below.

Highlights

Some of our operating highlights include:

- » relocation to our new facility;
- » upgrade of our customer contact points;
- » successful reattainment of NATA accreditation for both good laboratory practice and ISO 17025; and
- » successful recruitment of high quality staff.

With our move into the new Wine Innovation Central Building, the AWRI Commercial Services successfully relocated its operating facilities and fully re-established our services within a two week period. We took advantage of the relocation to streamline our workflows and implement lean laboratory operating principles.

Closures

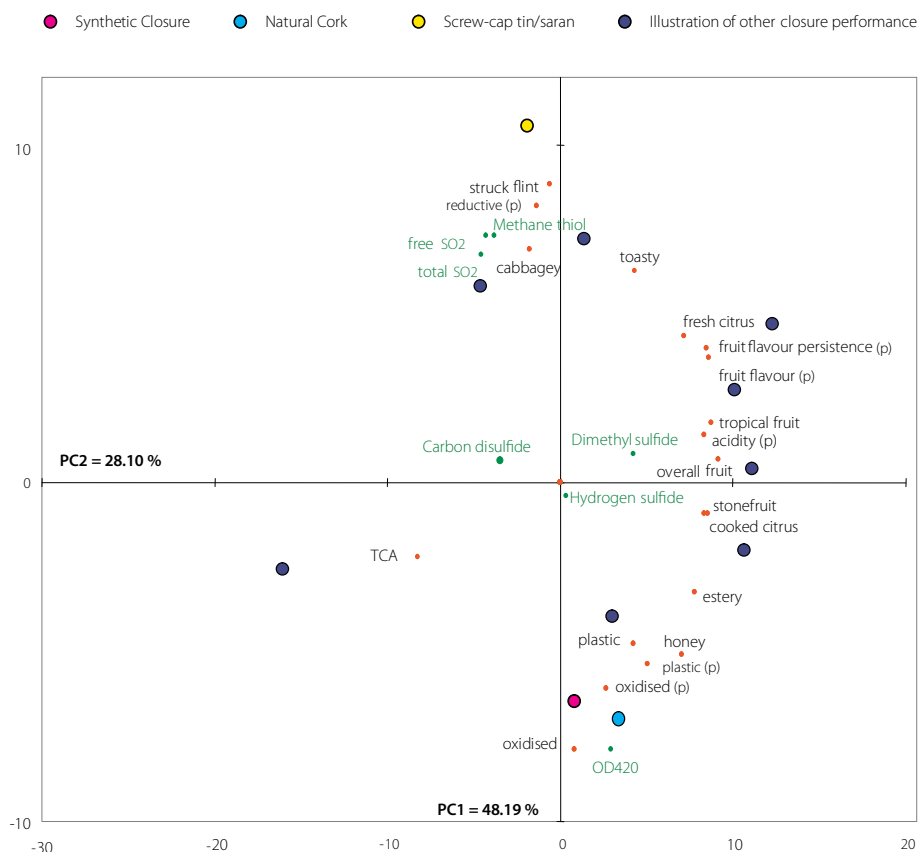


Figure 16. Principal component analysis plot showing 24 month testing interval results for our 2007 white wine closure trial



Team reports

This is the first step in our endeavour to build our capacity to provide customers with high quality, cost-competitive and fast turnaround services.

Our goal is to provide effective and user-friendly services for our customers. In order to achieve this we have initiated an upgrade of the following:

- » The content on the Commercial Services website, to improve the ease of access to analysis information and associated technical information;
- » Our information and financial systems to facilitate electronic reporting and commerce; and
- » Our branding to clarify for our users the fee-for-service support services from the AWRI's levy funded support activities.

Our ISO 17025 quality management system and Good Laboratory Practice accreditation underwent full audits this year by NATA. It is important to highlight that an initial application for NATA accreditation is a fairly simple process – it is the achievement of re-accreditation subsequent to a full audit by NATA that ensures a laboratory operates with robust and reliable quality systems; underpinning its capacity to provide credible analytical results. Not only were we successful in retaining our NATA accreditation we were commended on the technical ability of our staff, the quality of the facilities, analytical equipment and also recognised for appointing a dedicated person to the role of Quality Manager.

The quality of a business is underpinned by the quality of its staff. Finding and retaining quality staff is at the heart of our business development objectives as we strive to improve the quality of our services and maintain cost effectiveness. Implementation of 'employer of choice', personnel development programs, inclusive continuous improvement programs and moving to a new state of the art facility has helped us build our strong personnel engine room.

Packaging assessments

The AWRI enjoys a strong international reputation in the area of wine packaging evaluation and technical development. The AWRI pioneered closure benchmarking assessments for the Australian wine sector in 1999, with a large-scale study that provided knowledge which enabled producers to select closures fit for purpose. The AWRI has pushed the knowledge frontiers through a range of research studies on the effect of closure, storage variables and ascorbic acid on wine sensory properties yielding over 30 peer-reviewed publications. This technical know-how has created a large demand for commercial closure studies.

We have just completed the 24 month testing interval for our 2007 white wine closure trial which produced valuable insight into closure performance criterion for those involved.

Figure 16 shows a principal component analysis plot of the data obtained for selected variables analysed in the trial. In this plot, variables that are associated with each other are clustered together in the graph. The further you move from the origin the larger or more intense each variable becomes. Wines styles developed under the different closure technologies varied dramatically with wines displaying reductive attributes like cabbagey and struck flint towards the top of the graph. Wine with high fruit intensity are grouped slightly up and to the right of the graph. Wines with oxidised characters grouped towards the bottom of the graph. Each dot represents the average results for wines tasted 24 months after bottling for each closure technology. The direction of the dot from the intersection of the axis indicates the relevant attributes describing that wine under that closure. The further the dot from the centre – the greater the intensity of the attributes that were recorded.

Moving down and right on the graph, the sensory results are consistent for closures with high oxygen transmission rate (OTR) values with wines displaying cooked fruit and oxidised characters. Moving anti-clockwise around the intersection of the axis, the wine styles under the different closure technologies increase in fresh fruit characters consistent with lower OTR values, until vertically above the axis, the wine styles display reductive characters which are indicative of very low oxygen ingress levels. It is interesting to note that elevated levels of methane thiol were associated with these reductive attributes. The results for the screw-cap closure which contained a low OTR tin/saran wadding are located top centre of the graph.

The different wine styles developed under the closure technologies were evaluated by the AWRI sensory analysis team to determine which wine

styles were preferred in the Australian market place. The consumer preference results indicated one distinct market sector, comprising 30% of the demographic, preferred wines with elevated fresh fruit characters and disliked oxidised and TCA-tainted wines. Another distinct market sector, comprising 44% of the demographic, disliked reduced wines containing the struck flint attributes. These results may have implications for many Australian wineries which largely use screw-cap closures with tin/saran waddings on their wines.

We have now extended our packaging capability to include a service to measure the total package oxygen in a bottle comprising components in both the headspace and wine matrix. Benchmarking studies of several bottling operations around Australia were recently conducted in collaboration with Nomacorc using their Presens and oxyspot technology. The trial results shown in Figure 17 highlight that the oxygen levels in the headspace of a bottle contained on average over 65% of the total oxygen level in the package. In addition, the total oxygen levels bottled ranged from close to 4 mg/L down to 1 mg/L of wine. This is disturbing, given that none of these bottling operations monitored headspace oxygen levels as part of their control strategies. Oxygen levels of 4 mg/L can equate to over 10 years removed from a bottle's shelf life and significantly reduce the quality of the product.

A summary of some of the applications now available in our packaging assessment capability include:

- » quantification of Total Package Oxygen, i.e. Dissolved O_2 in wine matrix + Headspace O_2 ;
- » evaluation of the proficiency of the existing oxygen quality control systems;
- » detailed audit of entire packaging process;

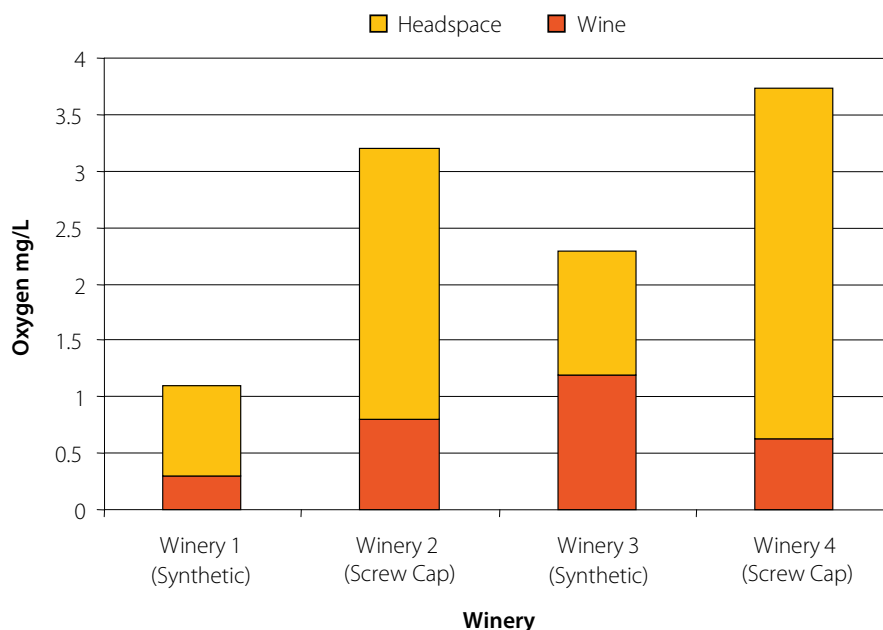


Figure 17. Results from our survey benchmarking oxygen management proficiency across a range of bottling lines



Table 9. Suite of quantifiable low molecular weight compounds

Compound	Odour descriptor	Aroma threshold (ug/L)	Typical range (ug/L)
Hydrogen sulfide	Rotten egg, sewage like	1	0 – 370
Methanethiol	Rotten cabbage, burnt rubber, putrid	1.5	0 – 11
Ethanethiol	Onion, rubbery, burnt match, sulfidy, earthy	1.5	0 – 50
Dimethyl sulfide	Blackcurrant, cooked cabbage, asparagus, canned corn, molasses	25	0 – 980
Carbon disulfide	Sweet, ethereal, slight green, rubber, sulfidy, chokingly repulsive	5	0 – 140
Diethyl sulfide	Garlic, rubbery	1	0 – 10
Methyl thioacetate	Sulfurous, cheesy, egg	40	0 – 115
Dimethyl disulfide	Vegetal, cabbage	10	0 – 22
Ethyl thioacetate	Sulfurous, garlic, onion	70	0 – 180
Diethyl disulfide	Bad smelling, onion	4	0 – 85

- » identification of O₂ pickup points throughout the process;
- » benchmark assessment of O₂ management performance relative to other bottling facilities; and
- » recommendation of practices to improve O₂ management.

Supplier technology evaluations

The AWRI Commercial Services provide a reliable and cost effective way for wineries and wine industry suppliers to assess the merits of novel technologies. Our assessments leverage our in-house expertise in winemaking operations, wine chemistry, microbiology, sensory analysis and chemical analysis. Effective evaluation of a given winemaking technology requires the following:

- » The identification of appropriate technology performance criterion in collaboration with our wine industry partners; and
- » Development of robust and technically proficient experimentation protocols to quantify performance against the selected criterion using our in house expertise.

Over the last financial year we have built-up services and a framework to provide robust and credible evaluations of supplier technologies for wineries. We put together experimental programs that quantify the key performance criterion of each technology and conduct experiments to quantify these parameters in a robust and reliable manner. This cannot be done effectively without the significant internal technical expertise in winemaking operations, and chemical and sensory analysis that we have at our disposal.

Over the last financial year we have evaluated technologies such as:

- » closure assessments;
- » additives such as fining agents, yeast strains and tannins;
- » technologies for cleaning barrels, pressing and micro-oxygenation;
- » bottling operations; and
- » novel analytical tools.

This service enables wineries to reduce the significant resources required and consequently the cost of conducting in-house trials. There is a plethora of available winemaking supplies and through referring suppliers to us, credible independent proof of performance data are obtained. Additionally, wineries and suppliers can participate in our advertised collaborating benchmarking programs, such as the 2009 red wine closure trial.

Novel analytical services

We have developed several novel analytical tools aimed to support wineries to build technical knowledge about their products and improve the efficiency of their operations. Some examples include:

- » low molecular weight sulfur compound analysis;
- » methoxypyrazines in wines and juice; and
- » spectral based tannin analysis in wines.

As outlined in last year's annual report, the AWRI Commercial Services launched the capacity to measure a suite of low molecular weight sulfur compounds shown in Table 9. Our low molecular weight sulfur analytical service has received widespread uptake, providing insight into compounds responsible for undesirable attributes in wines such as cabbage, onion rotten eggs and burnt rubber characters typically described as 'reductive'. Created primarily by yeasts, but also linked to storage of wines under closures with low OTR, these sulfur compounds can impart significant sensory impact to a wine even if present at trace levels.

The potential importance of such compounds for Australian wine producers is underlined by the fact that a noteworthy 2% out of 13,477 wines at the 2006 International Wine Challenge were judged as faulty due to the presence of excessive levels of these low molecular weight sulfide species in the wines. Furthermore, this value of 2% could be conservative as the reductive attributes need to be significant before they are classed as faulty.

The AWRI Commercial Services has recently developed a method to determine the concentration of key methoxypyrazine compounds in wine and juice. Methoxypyrazines are a group of compounds present in Sauvignon grape varieties and give resulting wines a range of herbaceous or vegetal aromas. These aromas can range from simple grassy or herbal tones to more vegetal characters, and are critical to defining wine style in Sauvignon Blanc and Cabernet Sauvignon wines.

Much research has been undertaken into these compounds to determine their importance and impact on the sensory perception of wines. Studies have shown that the sensory threshold for these compounds can be as low as 5-10 ng/L in some wines, and that the levels of these compounds can be affected by variations in viticultural and winemaking technique. The capability to quantify these compounds in wines should help winemakers develop an understanding of how to manage and control the attributes they affect in wine.

We have successfully commercialised a spectral based rapid tannin assay based on the MCP tannin assay developed at the AWRI and a modified Somers method also using spectral methods. This has enabled us to help winemakers quantify critical quality parameters such as tannin levels in their wines, colour density, hue, anthocyanins, bleachable polymers and total phenolics at a fraction of the cost.



Team reports

Corporate Services

Staff

Hans Muhlack, Catherine Borneman, Mark Braybrook, Michelle Carter, Andrew Cregan, Jeff Eglinton, Pauline Jorgensen, Linda Halse, Rhonda Milde, Jan O'Donnell, Susie Rock, Deborah Thornton-Wakeford, Jeanette Tooley

In order to create an environment where success is inevitable, particularly in a scientific environment, it is important to allow employees to participate and flourish in their chosen field of speciality. In order to succeed in this model and allow scientists to reach their full potential, a solid corporate support structure is vital.

The Corporate Services Group at the AWRI consists of a team of specialised and dedicated people who live the values of the organisation and whose prime focus is to provide high levels of service to both internal and external clients. With the organisation's reputation and with the Australian wine sector being a sought after area to work in, the AWRI has been fortunate to attract and retain people who have particularly unique skill sets. Our Group Manager is also the AWRI Company Secretary and has been working in the wine sector for in excess of 30 years. His wide and varied knowledge of prudent financial management and strategic understanding of the AWRI's role within the sector is a contributing factor to our successful Corporate Governance and financial strength. His role is supported by our Accountant whose chartered accounting qualifications and prior commercial experience ensure the integrity of AWRI's administration, accounting activities and statutory reporting.

Our IT Manager was previously employed as a microbiologist and these two attributes are very compatible when foreseeing the type and range of systems that are required to enable the success of our RDE&C model. Our OH&S Coordinator is a Chemist and therefore the move to the new WIC Central Building and the setting up of our new state of the art laboratories was extremely successful because of the proficiency and collaborate way in which he worked.

We have an HR Manager with an international and varied background who in 2008 was The Australian Human Resources Institute South Australian Finalist for HR Leader of the Year and the Finalist for HR Impact (team award). The strategic initiatives have included Leadership Development Programs for three tiers of the AWRI employees and many other new and innovative programs that have enabled the AWRI to maintain its reputation as an Employer of Choice.



Seated: Catherine Borneman
Standing: Hans Muhlack

The AWRI Operations Manager has many and varied strengths and project managed all aspects of the move to the new WIC Central Building saving the AWRI thousands of dollars through his exceptional negotiation skills.

The range of administrative and support roles from the Reception through to the Accounts Receivable and Payable have been outstanding contributors to client satisfaction. The entire team looks forward to the next year when they can streamline and further improve their services to reinforce the strength of the AWRI.





Financial report – Director's report

Your Directors present their financial report for the year ended 30 June 2009.

Review of Operations

The year began with plans for the AWRI's move into the new purpose-built Wine Innovation Central building well advanced. The actual move took place over one weekend in October 2008 with the aim of minimising the amount of interruption to the AWRI's operations. The majority of facilities were operational in the week following the move. However, there were long delays in achieving full operational functionality of the sensory facilities caused by design and construction issues which took a frustratingly long time to resolve.

The South Australian node of Metabolomics Australia, housed within the laboratory complex of the AWRI was opened in November 2008. This is a coup for the AWRI, not only because the facility is within the AWRI's laboratories and operated by the AWRI staff, but also because of the association with 'Bioplatforms Australia' (BPA). This association has resulted in a wine strain of *Saccharomyces cerevisiae* being adopted as a model organism for the development of systems biology capability across BPA platforms and nodes throughout Australia. Systems biology is the integration and application of data from different levels of 'omics' investigation to construct predictive models of complex biological systems. This represents a broadening of the base of scientific research, with potentially great benefit to the wine industry at no direct cost to levy payers.

The AWRI established a Tasmanian node in November 2008, as part of a consortium of Tasmanian industry members, to undertake a collaborative project entitled 'Improving Australian Sparkling Wine and Pinot Noir'. The AWRI has deployed a senior research scientist within the Sandy Bay campus of the University of Tasmania to provide oenological leadership to the project. The presence and involvement of an experienced the AWRI scientist has been well received by both producers and academic participants. The project is predominantly funded by the Australian Government's 'Industry Cooperative Innovation Program'. The GWRDC is also providing the AWRI with supplementary funding.

This year has also seen the completion of a major review of the activities of the Industry Applications Group within the AWRI. With the support and approval of GWRDC executive staff, projects have been revamped to give a stronger emphasis on environment, water and sustainability. In addition, there will be continuing development of platforms for web based analytical tools and a greater focus on regionality. There will also be an emphasis on improving the utilisation of existing knowledge in areas such as water and power efficiency.

The Industry Development and Support Group strives to ensure their broad suite of Extension activities continue to be contemporary and relevant to the needs of the grape and wine sectors. Examples include the development of alternative delivery formats such as web casts, facilitating increased electronic access to journals and articles and conducting training and other educational workshops. These services, together with the provision of advice, support and timely analyses in emergencies such as the 2009 bushfires, distinguish the AWRI's extension support to industry from the services of other extension providers.

The AWRI's Commercial Services continues to provide NATA-accredited chemical, microbiological and sensory analyses for its traditional customers. It has also expanded its project management and consulting capability to provide a much broader suite of services, including packaging assessments and bottling facility audits, as well as a range of scientific and engineering services to closure manufacturers and other packaging providers.

The year has also necessitated greater than usual contemplation of the AWRI's relationship with a number of important stakeholders. The modernisation of the AWRI's Constitution and composition of its Board and other initiatives designed to improve the AWRI's effectiveness and continuing value to

our stakeholders have been implemented. A great deal of time has been invested in maintaining open and positive dialogue with stakeholders to ensure that our Research, Development, Extension and Commercial activities continue to serve the needs of levy payers as a whole. More generally, the AWRI is proud to support the GWRDC's objective of providing social, environmental and economic benefits to regional and rural Australia in recognition of the public contribution to research funding. Similarly, the AWRI supports the effective use of the skills and resources of the community in general and the scientific community in particular.

Results of Operations

It is pleasing to report Revenue and Operating Surplus at record levels. The level of GWRDC project funding is historically high this year, although set to fall for the next four years in accordance with the Investment Agreement. However, the GWRDC has approved supplementary funding for the next four years that will mitigate much of that shortfall.

Alternative Government funding is predominantly through the capital funding received from Bioplatforms Australia as part of the Australian Government's National Collaborative Research Infrastructure Scheme (NCRIS). Funding through the South Australian State Government Premier's Science and Research Fund was also recognised. Commercial Services has shown a healthy increase in revenue reflecting a broader range of services now offered. The operating result also incorporates a significant gain on disposal of the old AWRI building.

It is important to note that just over 70% of the operating surplus is attributable to capital income which is capitalised rather than expensed. Accordingly, not all of the operating surplus is available for discretionary spending given that the capital component is earmarked for acquisition of specific capital equipment.

The increase in infrastructure and general services expenses is almost entirely attributable to WIC fit out expenses. Analytical and Project operating expenses are higher reflecting additional costs incurred in achieving the extra Commercial Services revenue as well as other contracted services utilised due to delays in filling staff vacancies during the year. There was also greater activity in bio-science project activities which required greater amounts of and relatively more expensive consumables.

Significant changes in state of affairs

There are no significant changes in the state of affairs of the AWRI.

PRINCIPAL ACTIVITIES

The principal activities of the AWRI have not significantly changed and are best described as:

- » *Research* activities which strive for scientific excellence and industry relevance;
- » *Development* activities that seek to bridge the gap between scientific discovery and value adding technology or processes;
- » *Extension* activities that seek to disseminate research and development outcomes to facilitate rapid uptake by the viticultural and winemaking sectors. In addition problem solving services and an on-line search capacity across a range of technical websites are also provided;
- » *Commercial* services aimed at providing competitive specific and/or tailored solutions for individual entities across all industry participants which leverage from the other key activities of the AWRI.



INFORMATION ON DIRECTORS

Directors of The Australian Wine Research Institute in office at any time during or since the end of the year:

Name and Qualifications and Experience	Special responsibilities	No. of Director's meetings attended	No. of Audit meetings attended	No. of N & R meetings attended
James Frederick Brayne , BAppSc(Wine Science), Production Director/Chief Winemaker McWilliams Wines Pty Ltd, National wine show judge, 36 years technical and winemaking experience in the Australian wine industry. (from 1/1/2009).		2		
Paul Conroy , LLB (Hons), Comm., Legal Affairs Director, Foster's Group Ltd, member of Chartered Secretaries of Australia, the Australian Corporate Lawyers Association. Admitted as solicitor in the Supreme Courts of NSW, Victoria and the High Court of Australia, over 18 years legal and management experience working in Australia, Asia, United Kingdom and United States.	Member of Audit Committee	4	1	
Peter James Dawson , BSc, BAppSc(Wine Science), formerly Senior Vice President Group Operations and Technical Constellation Wines, Adjunct Professor, Faculty of Science and Technology, Deakin University, National wine show judge, Inspector, Australian Wine and Brandy Corporation Export Approval Panel, 30 years technical and winemaking experience in the Australian wine industry.	Member Audit and N & R Committees	4	1	1
Robin Elliott Day , BAgSc, BAppSc(Wine Science), Director of Domain Day, former Board Member, Australian Wine and Brandy Corporation, National and International wine show judge, 36 years of production and R&D experience in the Australian wine industry. (to 31/12/2008)	Chairman	2		
Timothy Wickham Bevan James , AssDip (Wine Prod), Director, Wirra Wirra Vineyards, past President, SA Wine and Brandy Industry Association, past Deputy Chair, Grape and Wine Research and Development Corporation, Senior National Wine Judge, past Panel Chairman Sydney, McLaren Vale and Hunter Wine Shows, Deputy Chairman of the Adelaide Wine Show, past Chairman of the Barossa Valley Wine Show, past Chairman of the Canberra Wine Show, past Chairman of Cowra Wine Show, Graduate of Melbourne University Advanced Management Program 1985, Member of ASVO Publishing Committee, 32 years technical and winemaking experience in the Australian wine industry. (to 31/12/2008)		1		
Geoffrey Raymond Linton , BAppSc (App Chem), Grad Dip (Systems Analysis), Manager, Technical and Research, Yalumba Wine Company, member of the Wine Industry Technical Advisory Committee (AWBC, WFA), member Strategic Directions Group (WFA), 36 years experience in the Australian wine industry.	Member N & R Committee	4		2
James Anthony Lumbers , BSc, Lit B (public policy) ANU Principal Lumbers Consulting and Chairman Lerida Estate. Previously Board Member of Network Economic Consulting Group, Chairman ACT Chapter CSIRO Alumni Association, Member of Australian Institute of Agricultural Science, Canberra District, Canberra and District Wine Industry Association, Canberra and District Vignerons Association. (from 1/1/2009)	Member of Audit Committee (since February 2009)	2	1	
Brett Malcolm McKinnon , BAgSc (Oenology) (Hons), General Manager Viticulture and Winemaking, Orlando Wines, Executive Member SA Wine Industry Association, Member SA Wine Industry Council, Member WFA/WGGA Wine Industry Relations Committee, ASVO Professional Member, Graduate Leadership in Innovation Program INSEAD France, 21 years technical, winemaking, viticulture and commercial experience.		2		
Jan Sheree O'Connor , BEd (P. E.), Managing Director, O'Connor Harvesting, Committee Member, Robinvale & District Wine Grape Growers Association, Committee Member, Murray Valley Winegrowers Inc, Murray Valley Industry Development Committee, Phylloxera & Plant Health Technical Reference Group, and Australian Wine & Brandy Corporation Knowledge Development Advisory Committee, 23 years experience in the Australian wine industry.		4		
Isak Stephanus Pretorius , BSc Agric (Hons) PhD, Managing Director, The Australian Wine Research Institute Ltd, Professor Extraordinary in Oenology, University of Stellenbosch, Affiliate Professor in Oenology, University of Adelaide, Committee Member: Wine Industry Technical Advisory Committee (WFA/AWBC), Wine Committee Royal Agricultural and Horticultural Society (South Australia), Member, International Commission of Yeasts, Scientific Board of L'Institut des Sciences de la Vigne et du vin (ISVV) Bordeaux, France, Scientific Committee, Institut Català de Recerca en Enologia i Viticultura (ICREV) Tarragona Spain, Editorial Board Member, American Journal of Enology and Viticulture, Annals of Microbiology, FEMS Yeast Research, South African Journal of Enology and Viticulture, and Chair of the Australian Wine Industry Technical Conference, 32 years experience in microbiology and biotechnology.	Managing Director Member of N & R Committee	4		



Financial report – Director's report

Name and Qualifications and Experience	Special responsibilities	No. of Director's meetings attended	No. of Audit meetings attended	No. of N & R meetings attended
John Wilcox Stocker, AO MBBS PhD FRACP FTSE, Chairman CSIRO, Director of Telstra Corporation Ltd, Nufarm Limited and Foursight Associates Ltd. Previously Chairman of the Grape and Wine Research and Development Corporation and Sigma Company Ltd, a director of Walter and Eliza Hall Institute of Medical Research and a director of Cambridge Antibody Technology Plc. (from 1/1/2009)	Chairman Member N & R Committee	2		2
Mark Richard Watson , BEc, MBA, ACA, JPAA, AICD Partner KPMG, previously CFO Wirra Wirra and Manager, Corporate Strategy and Development, FH Faulding & Co Ltd.	Chair Audit Committee	4	2	
Stephen John Webber , BAppSc (Oenology), Chief Winemaker De Bortoli Yarra Valley, Chairman of Judges Melbourne Wine Show, Former Chairman of Cowra and Australia Small Winemaker Shows and 20 years of wine judging. 26 years technical and winemaking experience in Australia and France. <i>Australian Gourmet Traveller</i> Winemaker of the Year 2007. Winemaker and Director PHI Wines, a joint venture between the De Bortoli and Shelmerdine families (to 31 December 2008).		1		
Alternate Directors				
Nigel Peter Blieschke , BAppSc, GradCertVit, Viticultural Manager, Peter Lehman Wines.		1		
Leon Phillip Deans , BAppSc, Grad Dip (Business Administration), Innovations Manager, Pernod Ricard Pacific, committee member, Wine Industry Technical Advisory Committee, Board Member of Australian Wine and Brandy Corporation, 30 years winemaking experience in the Australian wine industry.				
James Northey , BSc, Grad Dip (BusAdmin), Management Systems Manager, Constellation Wines, member of the South Australian Wine Industry Association Environment Committee, 28 years experience in the Australian wine industry. (to 31/12/2007)				
Alexander Nikolai Sas , BSc Agric (Hons), Regional Viticulturalist, Constellation Wines, 20 years experience in viticultural R&D and grape supply management.				
Secretary				
Hans Engelbert Muhlack BEc CPA		4		

Four Board meetings, two Audit and two Nomination and Remuneration (N& R) Committee meetings were convened during the year

SHARE OPTIONS

No options to shares in the chief entity have been granted during the year and there were no options outstanding at the end of the year.

Auditor's independence declaration

The auditor's independence declaration under section 307C is attached.

Indemnification of officers and auditors

The Company has not, during or since the end of the year, in respect of any person who is or has been an officer or auditor of the chief entity or a related body corporate indemnified, or made any relevant agreement for indemnifying, against a liability, including costs and expenses, in successfully defending legal proceedings, or paid, or agreed to pay, a premium in respect of a contract insuring against a liability for the costs or expenses to defend legal proceedings.

Signed in accordance with a resolution of the Board of Directors this 3rd day of October 2009.



Dr J.W. Stocker AO
Chairman



Professor I.S. Pretorius
Managing Director



THE AUSTRALIAN WINE RESEARCH INSTITUTE LTD
A Company limited by Guarantee

INCOME STATEMENT
FOR THE YEAR ENDED 30 JUNE 2009

	Notes	2009 \$	2008 \$
Revenue from operating activities			
Grape and Wine Research and Development Corporation			
Project operating funds	9,507,373	8,841,018	
Project equipment funds	141,450	173,021	
Other Capital funds	531,571	173,861	
Other Grant Funding	1,799,971	629,808	
Commercial Services	1,817,918	1,495,495	
Contract Research and other Commercial Income	552,052	539,247	
Interest income	290,256	639,855	
Other revenue	440,212	457,171	
Total Revenue		15,080,803	12,949,476
Expenses from operating activities			
Employee benefit expense	8,860,702	8,586,085	
Analytical & Project Operating expenses	1,947,785	1,506,855	
Infrastructure & general services expenses	1,025,645	763,301	
Depreciation and amortisation expense 4 & 5	1,054,648	725,142	
Travel expenses	344,451	340,279	
Borrowing cost expense	0	0	
Total Expenses		13,233,231	11,921,662
Profit for the period		1,847,572	1,027,814
Net gain (loss) on disposal of assets			
Motor vehicles	0	27,230	
Buildings	675,717	0	
Other	(17,907)	(1,680)	
Profit from ordinary activities		2,505,382	1,053,364
Total changes in equity		2,505,382	1,053,364

THE AUSTRALIAN WINE RESEARCH INSTITUTE LTD
A Company limited by Guarantee

STATEMENT OF CHANGES IN EQUITY
FOR THE YEAR ENDED 30 JUNE 2009

	Retained Earnings	Other Reserves	Total
As at 1 July 2007	7,407,712	700,000	8,107,712
Profit for the year	1,053,364		1,053,364
Total recognised income & expenses for the period	1,053,364		1,053,364
Transferring reserves to retained earnings	700,000	(700,000)	
As at 1 July 2008	9,161,076	0	9,161,076
As at 1 July 2008	9,161,076	0	9,161,076
Profit for the year	2,505,382		2,505,382
Total recognised income & expenses for the period	2,505,382		2,505,382
Transferring reserves to retained earnings	0		
As at 1 July 2009	11,666,458	0	11,666,458

The Income Statement should be read in conjunction with the accompanying notes.



Financial report – Director's report

BALANCE SHEET AS AT 30 JUNE 2009

STATEMENT OF CASH FLOWS FOR THE YEAR ENDED 30 JUNE 2009

	Notes	2009 \$	2008 \$
Current assets			
Cash assets		5,490,411	5,576,903
Commercial bills	12	0	2,908,845
Trade and other Receivables	2	1,818,366	763,187
Other current assets	3	201,126	201,220
Total current assets		<u>7,509,903</u>	<u>9,450,155</u>
Non current assets			
Leasehold buildings	4	0	1,336,650
Plant and equipment	4	3,624,234	2,466,634
Interest in WIC Building	5	5,979,251	1,994,595
Total non current assets		<u>9,603,485</u>	<u>5,797,879</u>
TOTAL ASSETS		<u>17,113,388</u>	<u>15,248,034</u>
Current liabilities			
Payables and accruals	6	3,441,443	3,605,190
Project funds not expended and repayable			
GWRDC	7	269,566	907,338
Provisions	8	1,420,892	1,341,490
Total current liabilities		<u>5,131,901</u>	<u>5,854,018</u>
Non current liabilities			
Payables and accruals	6	58,340	62,014
Provisions	8	256,689	170,926
Total non current liabilities		<u>315,029</u>	<u>232,940</u>
TOTAL LIABILITIES		<u>5,446,930</u>	<u>6,086,958</u>
NET ASSETS		<u>11,666,458</u>	<u>9,161,076</u>
EQUITY			
Reserves	9	0	0
Retained earnings	10	11,666,458	9,161,076
TOTAL EQUITY		<u>11,666,458</u>	<u>9,161,076</u>

	Notes	2009 \$	2008 \$
CASH FLOWS FROM OPERATING ACTIVITIES			
Grants and other income		12,848,324	13,616,741
Interest received		290,256	639,855
Payments to suppliers and employees		<u>(12,050,049)</u>	<u>(11,582,460)</u>
Net cash provided by operating activities	11	1,088,531	2,674,136
CASH FLOWS FROM INVESTING ACTIVITIES			
Proceeds from (Payment for) commercial bills		2,908,845	(189,067)
Payments for Plant, Equipment & Interest in WIC Building		<u>(6,098,185)</u>	<u>(2,118,342)</u>
Proceeds from sale of plant and equipment		<u>2,024,100</u>	<u>30,032</u>
Net cash used in investing activities		<u>(1,165,240)</u>	<u>(2,277,377)</u>
CASH FLOWS FROM FINANCING ACTIVITIES			
Repayment of loans		(9,783)	(8,199)
Proceeds from loans		<u>0</u>	<u>0</u>
Net cash used by financing activities		<u>(9,783)</u>	<u>(8,199)</u>
Net increase (decrease) in cash held		<u>(86,492)</u>	<u>388,560</u>
Cash at 1 July		<u>5,576,903</u>	<u>5,188,343</u>
Cash at 30 June		<u>5,490,411</u>	<u>5,576,903</u>

The Statement of Cash Flows should be read in conjunction with the accompanying notes.

The Balance Sheet should be read in conjunction with the accompanying notes.



Notes to and forming part of the Financial report

1 STATEMENT OF ACCOUNTING POLICIES

The financial report has been prepared in accordance with applicable accounting standards, other mandatory professional reporting requirements and the Corporations Act 2001. The financial report has also been prepared on the basis of historical costs and does not take into account changing money values. Where necessary, comparative information has been reclassified to achieve consistency in disclosure with current financial year amounts and disclosures.

Australian Accounting Standards include Australian equivalents to International Financial Reporting Standards (IFRS). Compliance with the Australian equivalents to IFRS (AIFRS) ensures that the financial report complies with IFRS. No new Standards or Interpretations that have been issued but not adopted have been used in the preparation of this financial report.

The following is a summary of the significant accounting policies adopted by AWRI in the preparation of the financial report.

(a) Receivables and revenue recognition

Sales are recorded when goods or services have been provided to a customer.

Trade debtors are recognised at the amount receivable and are due for settlement within 30 days from the date of the invoice.

(b) Non-current assets

The cost method of accounting is used for the acquisition of assets. The acquisition of assets must be initiated by a purchase order.

The carrying amounts of non-current assets are reviewed at balance date to ensure that they are not valued in excess of their recoverable amount.

Plant and equipment is depreciated on a straight line basis to write off the net cost of each item of plant and equipment over its expected useful life. The expected useful lives are between 3 and 10 years.

Buildings and improvements are valued at cost and amortised over the estimated useful life of the buildings of 30 years.

(c) Payables and expenditure recognition

Purchases are recorded when a supplier has supplied goods or services. Trade creditors are unsecured and usually paid within each supplier's trading terms.

(d) Employee entitlements

(i) Wages, salaries and annual leave

Wages, salaries, annual leave and other employee benefits expected to be settled within twelve months of the reporting date are measured at their nominal amounts, including related on-costs.

(ii) Long service leave

Long service leave liabilities expected to be settled more than twelve months after the reporting date are measured such that the liability is not materially different from the estimate determined by using the present value of the estimated future cash outflows in respect of services provided up to the reporting date.

(e) Leases

Leases of fixed assets, where substantially all the risks and benefits incidental to the ownership of the asset, but not the legal ownership, are transferred to the entity are classified as finance leases.

Finance leases are capitalised, recording an asset and a liability equal to the present value of the minimum lease payments, including any guaranteed residual values.

Leased assets are depreciated on a straight line basis over their estimated useful lives where it is likely that the entity will obtain ownership of the asset. Lease payments are allocated between the reduction of the lease liability and the lease interest expense for the period.

Lease payments for operating leases, where substantially all the risks and benefits remain with the lessor, are charged as expenses in the period in which they are incurred.

Lease incentives under operating leases are recognised as a liability and amortised on a straight-line basis over the life of the lease term.

(f) Impairment

At each reporting date, the entity reviews the carrying values of its tangible and intangible assets to determine whether there is any indication that those assets have been impaired. If such an indication exists, the recoverable amount of the asset, being the higher of the asset's fair value less costs to sell and value in use, is compared to the asset's carrying value. Any excess of the asset's carrying value over its recoverable amount is expensed to the Income Statement. No adjustments for impairment were made this year.

Where the future economic benefit of the asset is not primarily dependent upon on the asset's ability to generate net cash inflows and when the entity would, if deprived of the asset, replace its remaining future economic benefits, value in use is depreciated replacement cost of an asset.

Where it is not possible to estimate the recoverable amount of an asset's class, the entity estimates the recoverable amount of the cash-generating unit to which the class of assets belong.

(g) Cash and Cash Equivalents

Cash and cash equivalents include cash on hand, deposits held at-call with banks, other short-term highly liquid investments with original maturities of three months or less, and bank overdrafts.

	2009 \$	2008 \$
2 RECEIVABLES		
Trade debtors	1,662,085	570,858
Other debtors	156,281	192,329
	<u>1,818,366</u>	<u>763,187</u>
3 OTHER CURRENT ASSETS		
Course materials	49,915	44,540
Prepayments	151,211	156,680
	<u>201,126</u>	<u>201,220</u>



Notes to and forming part of the Financial report

4 NON CURRENT ASSETS: AMORTISATION AND DEPRECIATION

	Leasehold buildings	Plant and equipment
Written down value		
Balance 30/06/2008	1,336,650	2,466,634
Additions	0	2,120,999
Disposals	(1,324,283)	(42,007)
Depreciation expense	(12,367)	(921,392)
Balance 30/06/2009	<u>0</u>	<u>3,624,234</u>

Proceeds on disposal of plant and equipment were \$24,100 in 2009 and \$30,032 in 2008.

Proceeds on disposal of buildings was \$2,000,000 in 2009.

5 INTEREST IN WIC BUILDING

AWRI has a 50 year nominal occupancy right to approximately 53% of the space in the WIC Central building owned by the University of Adelaide. The other occupants are the University of Adelaide and SARDI. The term of occupancy is reviewable after 30 years based on the remaining economic life of the building. The value assigned to AWRI's interest in the building as at 30 June 2009 is \$9.5m less the \$3.4m contributed by the GWRDC.

The South Australian State Government has also contributed \$9.5m to the cost of the building on behalf of all interested parties.

The Building cost will be amortised over a period of 30 years from the date of practical completion (26th November 2008).

Written down value	
Balance 30/06/2008	1,994,596
Additions (building Calls)	4,105,544
Disposals	0
Amortisation expense	(120,889)
Balance 30/06/2009	<u>5,979,251</u>

6 PAYABLES AND OTHER ACCRUALS

Current

Trade creditors	657,162	1,584,102
Income received in advance	883,017	1,132,290
PAYG and GST	409,563	305,848
Other creditors and accruals	1,480,028	573,167
Lease Liability	11,673	9,783
	<u>3,441,443</u>	<u>3,605,190</u>

Non current

Other creditors	38,000	30,001
Lease liability	20,340	32,013
	<u>58,340</u>	<u>62,014</u>

2009
\$

2008
\$

7 PROJECT FUNDS NOT EXPENDED

GWRDC Funding unexpended	269,566	907,338
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Any unexpended GWRDC funding other than core equipment funding is reimbursable to the GWRDC, except where the Joint Agreement Committee agrees that amounts can be retained by AWRI for purposes approved by the Joint Agreement Committee.

The unspent funds for 2009 was \$269,566 and \$422,836 in 2008.

During the year approval was given by the Joint Agreement Committee to utilise the prior years' balance of \$907,338.

8 PROVISIONS

Current

Employee entitlements	1,420,892	1,341,490
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Non current

Employee entitlements	256,689	170,926
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Number of Employees (FTE's)	102.5	95.8
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9 RESERVES

Capital reserve

Balance at the beginning of the year	0	700,000
Transferred to retained earnings	0	(700,000)
Balance at the end of the year	0	0

The Reserve was transferred to Retained Earnings on the basis that the Reserve was not created from any Asset revaluation, nor was there any residual mandated purpose for which the reserve had to be used.

10 RETAINED EARNINGS

Retained earnings at the beginning of the year	9,161,076	7,407,712
Profit from ordinary activities	2,505,382	1,053,364
Transfer from Capital Reserve	0	700,000
Retained earnings at the end of the year	<u>11,666,458</u>	<u>9,161,076</u>

11 RECONCILIATION OF NET CASH PROVIDED BY ORDINARY ACTIVITIES WITH ORDINARY PROFIT

Profit from ordinary activities	2,505,382	1,053,364
Non cash flows in operating profit		
Amortisation and depreciation	1,054,648	725,142
(Profit) loss on the sale of buildings, plant and equipment	(657,810)	(25,550)
Changes to (reduction in) provisions	165,165	237,523
Changes in assets and liabilities		
(Increase) decrease in receivables and other current assets	(1,055,085)	1,171,507
Increase (decrease) in sundry creditors and accruals	(923,769)	(487,849)
Net cash provided by ordinary activities	<u>1,088,531</u>	<u>2,674,136</u>



12 FINANCIAL INSTRUMENTS

Maturity analysis

The CBA Commercial Bill was redeemed and not renewed on 6 August 2008. The value at maturity was \$2,946,061.

Credit risk is managed by requiring new customers to complete an application for credit which seeks information about the organisation and their current trading activities to make trade reference enquiries. The application is approved if positive information is received. In the interim work is only undertaken on a prepayment basis. Monthly statements are issued and customers are contacted when invoices are more than 45 days overdue. Existing customers' work is held if any of their invoices are overdue more than 60 days. Credit on seriously overdue accounts is stopped and placed in the hands of a debt collection agency as a last resort. The aging of trade debtors as at 30 June 2009 compared to 2008 was as follows:

	2009	2008
	\$	\$
Current	1,401,551	338,442
Overdue: less than 30 days	125,334	144,515
Overdue: 30-60 days	31,785	82,628
Overdue: more than 60 days	103,415	5,273
	<u>1,662,085</u>	<u>570,858</u>

Cash flow analysis

Creditors are usually paid within 30 days unless specific other arrangements are entered into. Should any large foreign currency payment be required, exchange rate movements are usually hedged by taking out an appropriate forward exchange contract. The balance of the working account is checked daily and money is transferred from the Business Online Saver Account, if anticipated payments are likely to reduce the balance of the working account under \$100,000. Major funding income is deposited into the Business Online Saver Account, to take advantage of the higher interest rates offered by this account.

Sensitivity analysis

Given the strong cash position and minimal gearing of AWRI finances the impact of a 2% interest rate movement would not be considered material.

13 REMUNERATION OF KEY MANAGEMENT PERSONNEL

Key management personnel comprise directors and other persons having authority and responsibility for planning, directing and controlling the activities of AWRI.

Short-term employee benefits	1,409,832	1,328,834
Post-employment benefits	155,004	159,175
Termination benefits	0	0
Total	<u>1,564,836</u>	<u>1,488,009</u>

14 AUDITORS REMUNERATION

(a) For auditing the financial report	14,935	14,500
(b) For other services	6,925	3,595
	<u>21,860</u>	<u>18,095</u>

15 RELATED PARTIES

The following directors held office during the year:

Directors

John Wilcox Stocker
James Frederick Brayne
Peter James Dawson
Robin Elliott Day
Paul David Conroy
Timothy Wickham Bevan James
Geoffrey Raymond Linton
James Anthony Lumbers
Brett Malcolm McKinnon
Jan Sheree O'Connor
Isak Stephanus Pretorius
Mark Richard Watson
Steve John Webber

Alternate Directors

Nigel Peter Blieschke
Leon Phillip Deans
James Northey
Alexander Sas

Remuneration of Directors and key management personnel is disclosed in Note 13 to these accounts.

Related Entities

Transactions between related parties

	2009	2008
	\$	\$
Services received from Related Entities	116,526	92,185
Consisting of;		
Australian Wine Industry Technical Conference Inc.		
Provisor Pty Ltd		
Constellation Wines		
Domain Day Wines		
Wirra Wirra Vineyards		
McWilliam's Wines		
Orlando Wines		
Services provided to Related Entities	311,413	318,698
Consisting of;		
Australian Wine Industry Technical Conference Inc.		
Provisor Pty Ltd		
Constellation Wines		
Wirra Wirra Vineyards		
McWilliam's Wines		
Orlando Wines		
Drinkwise Australia		
Lerida Estate		

Services were provided to related entities on a purely arms length commercial basis.

16 FINANCIAL REPORTING BY SEGMENTS

The AWRI operates predominantly in one industry. The principal activities in the course of the financial year were research, development, extension and commercial scientific activities in connection with winemaking and viticulture. The AWRI operates predominantly in one geographical area, being Adelaide, South Australia. One employee works out of the Sandy Bay campus of the University of Tasmania.

17 LIMITED LIABILITY

The company is limited by guarantee. In the event of the company being wound up, the liability of each member (both during the time he or she is a member and within one year afterwards) is limited to two dollars. There are currently ten members.



Notes to and forming part of the Financial report

DIRECTORS' DECLARATION

In the opinion of the directors:

- (a) the accompanying financial report and notes set out on pages 46 to 54 are in accordance with the Corporations Act 2001, comply with the accounting standards and give a true and fair view of the company's financial position as at 30 June 2009 and of its performance for the year ended on that date; and
- (b) at the date of this declaration there are reasonable grounds to believe that the company will be able to pay its debts as and when they become due and payable.

Signed in accordance with a resolution of the directors.

Dr J. W. Stocker AO
Chairman

Professor I.S. Pretorius
Managing Director

At Adelaide this 3rd day of October 2009.

Auditor Independence Declaration

To the Directors of The Australian Wine Research Institute Ltd.

As lead engagement partner for the audit of The Australian Wine Research Institute Ltd for the year ended 30 June 2009, I declare that, to the best of my knowledge and belief, there have been:

- (a) no contraventions of the auditor independence requirements of the Corporations Act 2001 in relation to the audit; and
- (b) no contraventions of any applicable code of professional conduct in relation to the audit.

PKF

Chartered Accountants

I.J. Painter
Partner

Signed at Adelaide, this 3rd day of October 2009.

INDEPENDENT AUDIT REPORT TO MEMBERS OF THE AUSTRALIAN WINE RESEARCH INSTITUTE LTD

We have audited the accompanying financial report of The Australian Wine Research Institute Ltd, which comprises the balance sheet as at 30 June 2009, and the income statement, statement of changes in equity and cash flow statement for the year ended on that date, a summary of significant accounting policies, other explanatory notes and the directors' declaration.

Directors' Responsibility for the Financial Report

The directors of the company are responsible for the preparation and fair presentation of the financial report in accordance with Australian Accounting Standards (including the Australian Accounting Interpretations) and the *Corporations Act 2001*. This responsibility includes establishing and maintaining internal controls relevant to the preparation and fair presentation of the financial report that is free from material misstatement, whether due to fraud or error; selecting and applying appropriate accounting policies; and making accounting estimates that are reasonable in the circumstances. In Note 1, the directors also state, in accordance with Accounting Standard AASB 101 *Presentation of Financial Statements*, that compliance with the Australian equivalents to International Financial Reporting Standards ensures that the financial report, comprising the financial statements and notes, complies with International Financial Reporting Standards.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial report based on our audit. We conducted our audit in accordance with Australian Auditing Standards. These Auditing Standards require that we comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance whether the financial report is free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial report. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial report, whether due to fraud or error. In making those risk assessments, the auditor considers internal controls relevant to the entity's preparation and fair presentation of the financial report in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal controls. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by the directors, as well as evaluating the overall presentation of the financial report and the remuneration disclosures in the directors' report.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Independence

In conducting our audit, we have complied with the independence requirements of the *Corporations Act 2001*.

Auditor's Opinion

In our opinion the financial report of The Australian Wine Research Institute Ltd is in accordance with the *Corporations Act 2001*, including:

- (a) giving a true and fair view of the company's financial position as at 30 June 2009 and of its performance for the year ended on that date; and
- (b) complying with Australian Accounting Standards (including the Australian Accounting Interpretations) and the *Corporations Regulations 2001*.

PKF

A South Australian Partnership
Chartered Accountants

I.J. Painter
Partner

Signed at Adelaide, this 3rd day of October 2009.



Memorial Funds

THE JOHN FORNACHON MEMORIAL LIBRARY ENDOWMENT FUND

THE THOMAS WALTER HARDY MEMORIAL TRUST FUND

THE H.R. HASELGROVE MEMORIAL TRUST FUND

THE STEPHEN HICKINBOTHAM MEMORIAL RESEARCH TRUST

STATEMENT BY DIRECTORS OF THE TRUSTEE COMPANY

As detailed in note 2 to the accounts, the Trusts are not reporting entities because, in the Trustee's opinion, it is unlikely that users exist who are unable to command the preparation of reports tailored so as to satisfy, specifically, all of their information needs. This is a special purpose financial report that has been prepared to meet the reporting obligations of the Trustee.

In the opinion of the directors of The Australian Wine Research Institute Ltd:

- (a) The Income Statements give a true and fair view of each Trust's surplus for the year ended 30 June 2009;
- (b) The Balance Sheets give a true and fair view of each Trust's state of affairs as at 30 June 2009.
- At the date of this statement, there are reasonable grounds to believe that the Trusts will be able to pay their debts as and when they fall due.

This statement is made in accordance with a resolution of the Board of Directors of the trustee company and is signed for and on behalf of the directors by:

Dr J.W. Stocker AO
Chairman

Dated this 3rd day of October 2009.

INCOME STATEMENTS

	The John Fornachon Memorial Library Endowment Fund		The Thomas Walter Hardy Memorial Trust Fund		The H.R. Haselgrove Memorial Trust Fund		The Stephen Hickinbotham Memorial Research Trust	
	2009	2,008	2009	2,008	2009	2,008	2009	2,008
	\$	\$	\$	\$	\$	\$	\$	\$
For the year ended 30 June 2009								
Income								
Interest	4,579	6,540	4,668	6,925	3,796	4,399	5,574	6,548
Donations	0	0	0	0	0	0	0	0
	4,579	6,540	4,668	6,925	3,796	4,399	5,574	6,548
Expenditure								
Advertising	0	0	0	0	0	0	0	0
Audit fees	550	550	550	550	550	550	550	550
Bank charges	0	0	0	0	0	0	0	0
Technical Review contributions	0	0	0	0	0	0	0	0
Sponsorship	0	0	0	10,000	0	0	0	5,000
	550	550	550	10,550	550	550	550	5,550
SURPLUS (DEFICIT) FOR THE YEAR	4,029	5,990	4,118	-3,625	3,246	3,849	5,024	998



Memorial Funds

	The John Fornachon Memorial Library Endowment Fund		The Thomas Walter Hardy Memorial Trust Fund		The H.R. Haselgrove Memorial Trust Fund		The Stephen Hickinbotham Memorial Research Trust	
BALANCE SHEETS								
As at 30 June 2009	2,009	2,008	2,009	2,008	2,009	2,008	2,009	2,008
	\$	\$	\$	\$	\$	\$	\$	\$
Current Assets								
Cash at Bank	2	2	10	9	0	0	0	0
Receivables	680	1,744	625	1,846	0	0	0	0
Total Current Assets	682	1,746	635	1,855	0	0	0	0
Non-Current Assets								
Investments	108,193	103,650	99,510	109,722	71,355	68,659	101,666	102,192
Total Assets	108,875	105,396	100,145	111,577	71,355	68,659	101,666	102,192
Current Liabilities								
Sundry creditors	550	1,100	550	16,100	550	1,100	550	6,100
NET ASSETS	108,325	104,296	99,595	95,477	70,805	67,559	101,116	96,092
TRUST FUNDS								
Settled Sum	12,785	12,785	50	50	20,000	20,000	50	50
Founders Donation	0	0	25,000	25,000	0	0	0	0
	12,785	12,785	25,050	25,050	20,000	20,000	50	50
ACCUMULATED SURPLUS								
Opening balance	91,511	85,521	70,427	74,052	47,559	43,710	96,042	95,044
Surplus for the year	4,029	5,990	4,118	-3,625	3,246	3,849	5,024	998
Closing balance	95,540	91,511	74,545	70,427	50,805	47,559	101,066	96,042
TOTAL TRUST FUNDS	108,325	104,296	99,595	95,477	70,805	67,559	101,116	96,092



Memorial Funds

THE JOHN FORNACHON MEMORIAL LIBRARY ENDOWMENT FUND

THE THOMAS WALTER HARDY MEMORIAL TRUST FUND

THE H.R. HASELGROVE MEMORIAL TRUST FUND

THE STEPHEN HICKINBOTHAM MEMORIAL RESEARCH TRUST

1 NOTES TO AND FORMING PART OF THE ACCOUNTS

- (a) The John Fornachon Memorial Library Endowment Fund was established on 30 September 1970, to provide for the establishment and maintenance of the Fornachon Memorial Library, for the promotion of study and general knowledge of the wine industry. The Fund was established by way of public appeal on a memorial to the late John Charles Macleod Fornachon, the Director of Research of The Australian Wine Research Institute from 1955 to 1968.
- (b) The Thomas Walter Hardy Memorial Trust Fund was established on 29 June 1993 to assist in the communication of information within the wine industry and associated activities, allied to the wine industry on behalf of the Trust. The Trust was established in memory of the late Thomas Walter Hardy.
- (c) The H.R. Haselgrove Memorial Trust Fund was established on 12 December 1979 to provide for the promotion and encouragement of wine research by, or under the direction of, The Australian Wine Research Institute as a memorial to the late Harry Ronald Haselgrove.
- (d) The Stephen Hickinbotham Memorial Research Trust was established on 7 October 1986 to provide financial assistance and support in the pursuit of scientific research and associated activities, allied to the wine industry. The Trust was established in memory of the late Stephen John Hickinbotham. The Australian Wine Research Institute assumed responsibility for the Trust on 25 May 1992.

2 STATEMENT OF ACCOUNTING POLICIES

In the opinion of the Trustee, the Trusts are of a type identified in Statement of Accounting Concepts 1 as non-reporting entities. Accordingly, the financial statements constitute a 'Special Purpose Financial Report' which has been prepared solely to meet the reporting obligations of the Trustee, and the limited information needs of the Trusts' members.

The financial statements have been prepared in accordance with accounting standards, except as stated below, and other mandatory professional reporting requirements.

The following accounting standards have not been adopted because, in the opinion of the Trustee, the cost of compliance outweighs the benefit of the resultant information:

AAS22 Related Party Disclosures
AAS28 Statement of Cash Flows
AAS33 Presentation and Disclosure of Financial Instruments

The financial statements have been prepared on an accrual basis.

Accounting policies have been consistently applied, with the only significant policy being in relation to investments.

Investments comprise money on deposit, and are recorded at their nominal value. Interest is brought to account as earned, with accrued interest at balance date being included in the balance sheet as receivables.

AUDITOR'S REPORT

TO THE TRUSTEE OF

THE JOHN FORNACHON MEMORIAL LIBRARY ENDOWMENT FUND

THE THOMAS WALTER HARDY MEMORIAL TRUST FUND

THE H.R. HASELGROVE MEMORIAL TRUST FUND

THE STEPHEN HICKINBOTHAM MEMORIAL RESEARCH TRUST

Scope

We have audited the financial statements, being special purpose financial reports, of The John Fornachon Memorial Library Endowment Fund, The Thomas Walter Hardy Memorial Trust Fund, The H. R. Haselgrove Memorial Trust Fund and The Stephen Hickinbotham Memorial Research Trust for the year ended 30 June 2009, as set out on pages 55 to 57. The Trustee is responsible for the preparation and presentation of the financial statements and the information they contain and has determined that the accounting policies used and described in Note 2 to the accounts are appropriate to meet the needs of the members. We have conducted an independent audit of these financial statements in order to express an opinion on them to the members on their preparation and presentation.

Our audit has been conducted in accordance with Australian auditing standards. Our procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial statements and significant accounting estimates. These procedures have been undertaken to form an opinion as to whether, in all material respects, the financial statements are presented fairly in accordance with the accounting policies described in Note 2 to the accounts. These policies do not require the application of all accounting standards and mandatory professional reporting requirements.

The audit opinion expressed in this report has been formed on the above basis.

Audit Opinion

In our opinion, the financial statements of The John Fornachon Memorial Library Endowment Fund, The Thomas Walter Hardy Memorial Trust Fund, The H.R. Haselgrove Memorial Trust Fund and The Stephen Hickinbotham Memorial Research Trust for the year ended 30 June 2009 are properly drawn up in accordance with applicable Australian accounting standards. As the Trustee has determined that the Trusts are non-reporting entities, accounting standards and other mandatory professional reporting requirements have only been applied to the extent described in Note 2 to the accounts.

PKF

A South Australian Partnership
Chartered Accountants



I.J. Painter
Partner

Signed at Adelaide this 3rd day of October 2009.



Appendix 1 – External presentations and talks

Staff	Title of talk	Presented to and where	Date
J.R. Bellon	Hybrid wine yeast and flavour diversity	Enology Research Department, Gallo Winery, Modesto California and Stanford University, California, USA	14 Jul 2008
		Yeast Genetics Department, Stanford University, California, USA	18 Jul 2008
P.A. Henschke	Critical roles of yeast in shaping wine flavour	School of Biological Sciences, Flinders University, SA	23 Jul 2008
C.S. Stockley	National and internation wine and health issues	Orlando Wines, Roland Flat, SA	
A.D. Coulter	Haze and sediment identification	Interwinery Analysis Group, Barossa Valley Convention Centre, SA	25 Jul 2008
G.D. Cowey	Preventing wine taints and faults		
E.J. Waters	Heat stability – defining the chemistry		
C.A. Simos	Smoke taint	GWRDC workshop, Attwood, Vic.	29 Jul 2008
A.D. Coulter	Heat wave and stuck fermentations	Clare Valley Vignerons, Seven Hill Hotel, Clare Valley, SA	7 Aug 2008
E.J. Bartowsky	Science and bacteria: from cholera to antibiotics, wasps and onto wine	Science Week: Burnside Primary School Year 5 students. Burnside Primary School, Burnside, SA	27 Aug 2008
P.J. Chambers	What makes a wine yeast tick	12th International Congress on Yeasts, Kiev, Ukraine	12 Aug 2008
C.S. Stockley	National and internation wine and health issues	Pernod Ricard Pacific, Dulwich, SA	26 Aug 2008
R.A. Muhlack	Filling the potholes in the environmental research landscape	‘Footprints, food miles and furbhies’ Australian Society of Viticulture and Oenology (ASVO) Seminar, Adelaide, SA	10 Sept 2008
G.D. Cowey	Simulated faulty wine tasting	AWBC and Wine Australia USA wine educators	10 Sept 2008
	2008 Heat wave and stuck fermentations	AWRI Fermentation workshop - McLaren Vale Grape Wine & Tourism Association, McLaren Vale Visitors Centre, SA	11 Sept 2008
S-J. Bell	Can vine and wine nutrient status affect wine quality?	McLaren Vale Winemakers Seminar, McLaren Vale Visitors Centre SA	19 Sept 2008
I.L. Francis	Sensory and non-sensory influences on informed tasting preference	GWRDC and project advisory group, Adelaide, SA	
C.A. Simos	Tasting and benchmarking	26 th AWAC, Lilydale campus, Swinburne University, Lilydale, Vic.	
G.D. Cowey	Simulated faulty wine tasting		
I.L. Francis	Tasting and discussion of flavour standards		
R. Gawel	Palate performance and statistical evaluation		26 Sept 2008
I.L Francis, P. Osidacz	Understanding Chinese consumer preferences	Wine industry project advisory group, AWRI, Urrbrae, SA	25 Sept 2008
C.S. Stockley	Alcohol and health	Rutherglen Wine Show, 21st Annual Seminar, Rutherglen, Vic.	
S-J. Bell	Best management for nitrogen fertilisers	Yalumba Growers Seminar, Yalumba Winery, Angaston, SA	30 Sept 2008
I.S. Pretorius	Annual report	Queensland Wine Industry Association, Toowoomba, Qld	7 Oct 2008
G.D. Cowey	Preventing wine taints and faults	New England Wine Show, Glen Innes Showground, NSW	17 Oct 2008
C.S. Stockley	The development of alcohol policy in Australia – changes, and current and emerging issues	Pernod Ricard Research Centre, Paris, France	20 Oct 2008
I.L. Francis	Understanding the taste preferences of wine consumers	International Alcohol Drinks Conference, Beijing, China	
M.G. Holdstock	Copper use in winemaking	Australian Small Winemaker’s Show, Stanthorpe, Qld	21 Oct 2008
R. Gawel	The role of ethanol and glycerol on white wine body	AWRI Roadshow, Griffith, NSW	
	Wine development in bottle – impact of closures, storage conditions and ascorbic acid addition		
	Impact of ullage volume under screw cap (ROTE) on chemical composition and sensory properties of a Cabernet Sauvignon wine (ex AWITC)		



Staff	Title of talk	Presented to and where	Date
S-J. Bell	Can vine and wine nutrient status affect wine quality? – Impact of nitrogen on grape and wine quality	AWRI Roadshow, Griffith, NSW	21 Oct 2008
R.G. Dambergs	50 Vintages of Wynns Coonawarra Cabernet – a study of anthocyanin and tannin maturation		
	Commercial wine quality grading – correlations with spectral properties		
	Measuring phenolics in grapes and wine		
M.J. Herderich	Phew! What is that stench??? Low molecular weight sulfur compounds in wine		
E.J. Bartowsky	Strategies for successful induction of malolactic fermentation		
	Flavour aspects of MLF – control of the ‘buttery’ diacetyl character in wine		
C.A. Simos	Understanding and avoiding sub-optimal fermentation (stuck and off-flavours)		
S.J. Bell	Impact of nitrogen on grape and wine quality	AWRI Roadshow, Wangaratta, Vic.	22 Oct 2008
R. Gawel	The link between bentonite requirements and vineyard and winemaking practices		
P.A. Smith	White juice and wine phenolics		
	Grape and wine tannins, red wine colour and mouth-feel – an overview on current research, emerging applications and future challenges		
	Strategies for the control of <i>Dekkera/Brettanomyces</i> during winemaking		
R.G. Dambergs	An industry survey of grape colour, tannin, TSS (Brix) and crop yield – with some implications for winemaking		
	Grapes to glass – rapid, cost effective monitoring of the winemaking process		
M.J. Herderich	Grape maturity and tannins: the impact of viticultural treatments on grape and wine tannins		
	Modulation of Sauvignon Blanc aroma through co-inoculation of yeast strains		
C.A. Simos	Winemaking implications for the management of smoke and bush fire taints		
E.J. Bartowsky	Strategies for successful induction of malolactic fermentation		
C.D. Curtin	Making white wine for consumers	Anchor Yeast Technical Meeting, Stellenbosch, South Africa	23 Oct 2008
	<i>Brettanomyces</i> : management strategies and research		
R. Gawel	Impact of ullage volume under screw cap on the chemical composition and sensory properties of a Cabernet Sauvignon wine	AWRI Roadshow, Canberra, ACT	24 Oct 2008
	The link between bentonite requirements and vineyard and winemaking practices		
S-J. Bell	Impact of nitrogen on grape and wine quality		
P.A. Smith	White juice and wine phenolics		
	Measuring phenolics in grapes and wine		
	Grape and wine tannins, red wine colour and mouth-feel – an overview on current research, emerging applications and future challenges		
M.J. Herderich	Grape maturity and tannins: the impact of viticultural treatments on grape and wine tannins		
	Pepper aroma in Shiraz		



Appendix 1 – External presentations and talks

Staff	Title of talk	Presented to and where	Date
E.J. Bartowsky	MLF inoculation regimes – affect on sensory and chemical composition	AWRI Roadshow, Canberra, ACT	24 Oct 2008
C.A. Simos	Practical QC and bottling aspects		
	Understanding and avoiding sub-optimal fermentation (stuck and off-flavours)		
D. Cozzolino	Rapid technologies to evaluate grape composition: limitations and realities	Conferencias da Tapada, Lisbon, Portugal	29 Oct 2008
L. Halse	How the AWRI recruits critical international talent	Collective Learning Australia, Employer Branding Summit, SA	31 Oct 2008
A.D. Coulter	Simulated taints/faults in red and white wine	UK Circle of Wine Writers at the AWRI, Urrbrae, SA	4 Nov 2008
I.L. Francis	Oxygen and wine style: what do consumers prefer?	Winetechology@work seminar, Victoria Institute of Technology, Bendigo, Vic.	11 Nov 2008
C.A. Simos	Tasting and benchmarking	27 th AWAC, Adelaide, SA	11 and 13 Nov 2008
B. Travis	Tasting and discussion of flavour standards		11 Nov 2008
G.D. Cowey	Simulated faulty wine tasting		
P.W. Godden	Tasting and benchmarking		12 Nov 2008
R. Gawel	Assessing sweet wines		13 Nov 2008
	Measuring judge performance		14 Nov 2008
I.L. Francis, P. Osidacz	Understanding Chinese consumers' red wine preferences	Orlando Wines, Rowland Flat, SA	18 Nov 2008
		Orlando Wines, Dulwich, SA	20 Nov 2008
G.D. Cowey	The avoidance of taints and chemical instabilities during winemaking	AWRI Roadshow (workshop) Canberra, ACT	
	Methods to assess taints in winemaking additives		
M.G. Holdstock	The avoidance of taints and chemical instabilities during winemaking - case studies		
	Wine taint prevention		
	A tasting of real wines with 'real' taints		
A.D. Coulter	A tasting of wines with simulated taints and faults		
	Instabilities from wine additives		
M. Ugliano	Assimilable nitrogen: the Yin and YANG of fermentation		
I.S. Pretorius, R.G. Damberg	Overview of the role of the AWRI node and research goals with regard to Pinot Noir vinification		
I.L. Francis	Oxygen and wine style: what do consumers prefer?		
R. Gawel	Effect of terroir and viticultural practice on the in-mouth texture of South Australian Shiraz wines	3rd International Symposium of Sangiovese, Firenze, Italy	3 Dec 2008
E.S. King	Improving quality of Australian Sauvignon Blanc wines. Co-inoculation of yeast strains affect consumer preference	10 th Scientific Meeting of the Australasian Association of Chemosensory Science (AACSS), Brisbane, Qld	4-6 Dec 2008
G.D. Cowey	The avoidance of taints and chemical instabilities during winemaking	AWRI Roadshow (workshop), Griffith, NSW	9 Dec 2008
	Methods to assess taints in winemaking additives		
C.A. Simos	The avoidance of taints and chemical instabilities during winemaking - case studies		
	Wine taint prevention		
	A tasting of real wines with 'real' taints		
A.D. Coulter	A tasting of wines with simulated taints and faults		
	Instabilities from wine additives		
M. Ugliano	YAN and the art of fermentation management	Coonawarra Viticulture Workshop, Coonawarra, SA	11 Dec 2008



Staff	Title of talk	Presented to and where	Date
S-J. Bell	Can vine and wine nutrient status affect wine quality? Manipulation of phenolic profiles in red grapes and wine by viticultural management	Coonawarra Viticulture Workshop, Coonawarra, SA	12 Dec 2008
C.D. Curtin	AWRI yeast trial 2008: Benchmarking strains for unwooded Chardonnay production	Winemakers, Pernod Ricard Pacific, Rowland Flat, SA	17 Dec 2008
E.J. Waters	Measuring oxidation by non-destructive methods	O ₂ in Wines Conference, Santiago, Chile	9 Jan 2009
G.D. Cowey	The avoidance of taints and chemical instabilities during winemaking	AWRI Roadshow (workshop). Avoca Pyrenees, Blue Pyrenees Estate, Avoca, VIC	14 Jan 2009
	Wine taint prevention		
	Methods to assess taints in winemaking additives		
A.D. Coulter	www.awri.com.au. The AWRI website		
	Instabilities from winemaking additives		
	The avoidance of taints and chemical instabilities – case studies		
M.G. Holdstock	A tasting of wines with simulated taints and faults	AWRI Roadshow (workshop). Bendigo Regional Institute of TAFE, Bendigo, VIC	15 and 16 Jan 2009
	A tasting of real wines with 'real' taints		
G.D. Cowey	The avoidance of taints and chemical instabilities during winemaking.		
	A tasting of wine with simulated taints and faults		
A.D. Coulter	www.awri.com.au. The AWRI website.		
	A tasting of real wines with 'real' taints		
	Instabilities from winemaking additives	AWRI Roadshow, Avoca – Pyrenees, Avoca Information Centre, Avoca, Vic.	16 Jan 2009
M.G. Holdstock	The avoidance of taints and chemical instabilities – case studies.		
	Wine taint prevention methods to assess taints in winemaking additives		
M. Ugliano	Wine varietal aroma		
	Fermentation nitrogen and wine aroma		
A.D. Coulter	Simulated tainted/faulty wine tasting	Geelong Winegrowers Association wine faults workshop, Deakin University, Geelong, Vic.	19 Jan 2009
	Simulated tainted/faulty wine tasting	Melbourne Masters of wine seminar, William Angliss TAFE, Melbourne, Vic.	20 Jan 2009
	<i>Brettanomyces</i> research and practical control measures		
P.R. Dry	Vine balance and wine quality	AWRI Roadshow, Avoca – Pyrenees, Avoca Information Centre, Avoca, Vic.	21 Jan 2009
	Insights into varietal and rootstock differences in water use		
H.E. Holt	Grape and wine tannins, red wine colour and mouth-feel – an overview on current research, emerging applications and future challenges		
M. Essling	Understanding how vines cope with periods of hot weather and extended drought conditions		
	Sustainable salinity management in your vineyard		
C.A. Simos	Strategies for the control of <i>Dekkera/Brettanomyces</i> , during winemaking		
	Practical QC and bottling aspects	AWRI Roadshow, Bendigo Regional Institute of TAFE, Bendigo, Vic.	21 Jan 2009
P.A. Henschke	Causes and control of mousy off-flavour in wine		
R. Gawel	White wine ageing: the role of ascorbic acid and bottle storage conditions		
P.R. Dry	Do you really have a poor fruit set?	AWRI Roadshow, Bendigo Regional Institute of TAFE, Bendigo, Vic.	21 Jan 2009



Appendix 1 – External presentations and talks

Staff	Title of talk	Presented to and where	Date
H.E. Holt	Grape and wine tannins, red wine colour and mouth-feel – an overview on current research, emerging applications and future challenges	AWRI Roadshow, Bendigo Regional Institute of TAFE, Bendigo, Vic.	21 Jan 2009
	An industry survey of grape colour, tannin, TSS (Brix) and crop yield – with some implications for winemaking		
M. Essling	It's getting hotter – but should we panic?		
P.R. Dry	Vine balance and wine quality		
R. Gawel	Protein haze in white wines: new solutions to an old problem		
	White wine ageing: the role of ascorbic acid and bottle storage conditions		
P.A. Henschke	Potential for fermentation yeast and bacteria to modify red wine colour and flavour – results from recent laboratory and pilot scale experiments		
	Which bacterial strains are conducting MLF and what are the consequences?		
R.G. Dambergs	AWRI – the Tasmanian connection	UTas Food Safety Group, Sandy Bay, Tas.	23 Jan 2009
C.A. Simos	Bush fire / Smoke taint	Briefing with Yarra Valley Winemakers, Punt Road Winery, Yarra Valley, Vic.	7 Feb 2009
I.S. Pretorius	Metabolomics: a new paradigm for wine research	14 th Lorne Metabolomics Symposium, Lorne, Vic.	8 Feb 2009
G.D. Cowey	www.awri.com.au. The AWRI website	AWRI Roadshow (workshop). University of Tasmania, Sandy Bay Campus, Hobart, TAS	10 Feb 2009
	A tasting of real wines with 'real' taints		
A.D. Coulter	Taints and contaminations		
	A tasting of wines with simulated taints and faults		
	Instabilities from winemaking additives		
M.G. Holdstock	The avoidance of taints and chemical instabilities – case studies		
	Wine taint prevention		
	Methods to assess taints in winemaking additives		
G.D. Cowey	www.awri.com.au. The AWRI website		11 Feb 2009
	A tasting of real wines with 'real' taints		
A.D. Coulter	Taints and contaminations		
	A tasting of wines with simulated taints and faults		
	Instabilities from winemaking additives		
M.G. Holdstock	The avoidance of taints and chemical instabilities – case studies.		
	Wine taint prevention		
	Methods to assess taints in winemaking additives		
S. Schmidt	Automation in wine yeast research: delivering flexible and high-throughput solutions	34 th Lorne conference on protein structure and function, Lorne, Vic.	11 Feb 2009
R.G. Dambergs	The link between UTAS and AWRI	AWRI Roadshow, The Tasmanian Skills Institute, Newnham, Tas.	12 Feb 2009
	Grape and wine quality – what to measure and how to do it		
	White juice and wine phenolics	AWRI Roadshow, University of Tasmania, Sandy Bay Campus, Hobart, Tas.	13 Feb 2009
P.R. Dry	So you think you have poor fruit set?		
	Vine balance and wine quality		
S-J. Bell	Impact of nitrogen on grape and wine quality		
	Does grapevine nutrition have an impact on wine quality?		



Staff	Title of talk	Presented to and where	Date
M. Essling	The management of <i>Botrytis</i> bunch rot	AWRI Roadshow, University of Tasmania, Sandy Bay Campus, Hobart, Tas.	13 Feb 2009
	Grape maturity and tannins: the impact of viticulture treatments on grape and wine tannins		
C.A. Simos	Quality control and bottling aspects		
P.J. Chambers	Variation under domestication: domestic yeasts, their differences and origins	Evolution – The Experience Conference, Melbourne Convention Centre, Melbourne, Vic.	11 Feb 2009
I.S. Pretorius	Annual report presentation	South Australian Wine Industry Association, Adelaide, SA	20 Feb 2009
C.S. Stockley	Summary and outcomes of the informal OIV allergen working group meeting held on 21 October 2008	OIV Food Safety Expert Group, Paris, France	12 Mar 2009
	The new Australian Guidelines to reduce health risks from drinking alcohol	OIV Nutrition and Health Expert Group, Paris, France	13 Mar 2009
R.G. Damberg	AWRI – The Tasmanian connection	UTas Ag Science Department, Sandy Bay, Tas.	
P.A. Smith	An update on Industry Applications development projects	Wynns Coonawarra staff, Wynns Coonawarra, Coonawarra, SA	27 Mar 2009
I.L. Francis	Australian Sauvignon Blanc and Cabernet Sauvignon wines	Wine Guild of SA, North Adelaide Primary School, Adelaide, SA	5 Apr 2009
I.S. Pretorius	The new frontier – breakthroughs in the science of wine yeast	AB Mauri sponsored delegation of scientists and wine practitioners, Alzey, Germany	20 Apr 2009
E.J. Waters	Wine development post-bottling: data from bottling trials in 2007 and 2009	Nomacorc Closure Council, National Wine Centre, Adelaide, SA	21 Apr 2009
R.G. Damberg	Spectroscopy and chemometrics – rapid analysis tools for the wine industry	Enoforum 2009, Piacenza, Italy	22 Apr 2009
I.S. Pretorius	The new frontier – breakthroughs in the science of wine yeast		
R.G. Damberg	Performing surgery on grape juice and wine – the use of industrial scale tools to dissect and modify compositional profiles		23 Apr 2009
I.S. Pretorius	The new frontier – breakthroughs in the science of wine yeast	Seminario Tecnico, Universidad Rovira I Virgili, Tarragona, Spain	
C.D. Curtin	Bioscience research at The Australian Wine Research Institute	Wine Science students, University of Gothenburg, Sweden	
I.S. Pretorius	The new frontier – breakthroughs in the science of wine yeast	Seminario Tecnico, Madrid, Spain	24 Apr 2009
C.D. Curtin	Yeast's influence on cool-climate Chardonnay's volatile aroma compound profiles, sensory attributes, and consumer preferences	Lallemand Entrepreneurs Scientifique, Geisenheim Research Station, Geisenheim, Germany	
C.D. Curtin	Bioscience research at The Australian Wine Research Institute	AB Mauri staff, Sydney, NSW	21 May 2009
C.S. Stockley	National and international wine and health issues	Constellation Wines, Adelaide, SA	22 May 2009
D. Cozzolino, W.U. Cynkar, N. Shah	Methods in food analysis	FOSC 3002, Food Processing and Manufacturing, School of Pharmacy and Medical Sciences, University of South Australia, SA	25 May 2009
E.J. Waters, I.L. Francis, M. Parker	White Wine Phenolics Steering Committee - progress update	GWRDC Board room, Adelaide, SA	
C.S. Stockley	Wine and cognitive health	Royal Australian and New Zealand College of Psychiatrists 2009 Congress, Adelaide, SA	26 May 2009
S-J. Bell	Agrochemical issues and major changes to the 2009/2010 Agrochemical booklet	IHD Vitilink Agronomy Forum, Hunter Valley, NSW	
G.D. Cowey	The avoidance of taints and chemical instabilities during winemaking – case studies	AWRI Roadshow (workshop), Hunter Valley, NSW	27 May 2009
	Wine taint prevention		



Appendix 1 – External presentations and talks

Staff	Title of talk	Presented to and where	Date
M.G. Holdstock	The avoidance of taints and chemical instabilities during winemaking	AWRI Roadshow (workshop), Hunter Valley, NSW	27 May 2009
	Instabilities from wine additives		
	A tasting of real wines with 'real' taints		
E.L. Kennedy	Methods to access taints in winemaking additives		
	www.awri.com.au. The AWRI website		
S-J. Bell	Can vine and wine nutritional status have an impact on wine quality?	AWRI Roadshow, Hunter Valley, NSW	28 May 2009
	Manipulation of phenolic profiles in red grapes and wine by viticultural management		
P.R. Dry	Cultural practices to improve fruitset		
	Understanding how vines cope with hot weather and extended drought conditions		
E.J. Bartowsky	MLF inoculation regimes: co-inoculation or sequential – potential wine flavour modifications		
	Strategies for successful induction of malolactic fermentation		
	Which bacterial strains are conducting MLF and what are they consequences?		
J.A. Kennedy	Grape maturity and tannins: the impact of viticultural treatments on grape and wine tannins		
A.D. Coulter	Simulated tainted/faulty wine tasting	Queensland College of wine tourism 'Gateway Schools Project', AWRI, SA	1 June 2009
G.D. Cowey, M.G. Holdstock, E.L. Kennedy, A.D. Coulter, C.A. Simos	AWAC style tasting and presentation	Landmark Tasting, Wine Australia, Adelaide, SA	1 June 2009
Y. Hayasaka	How can we measure the potential of grapes to produce smoke-affected wine?	The impact of smoke on vineyards and wines workshops - Yarra Valley Winegrowers' Association, Swinburne University, Vic.	12 June 2009
C.A. Simos	Progress report: activities from the 2009 Victorian fire event		
M.J. Herderich	Smoke taint: future research directions		
E.J. Bartowsky	Overview of wine micro research at The Australian Wine Research Institute	Washington State University, Viticulture and Enology, Richmond, Washington State, USA	
D.L. Capone	Development and application of novel analytical methods to the identification, formation and fate of important wine aroma compounds	University of Adelaide, Adelaide, SA	
E.J. Bartowsky	Wine aroma and flavour development by <i>Oenococcus oeni</i> during malolactic fermentation	Sonoma County Winemakers Tech Group, Santa Rosa, California, USA	16 June 2009
D. Cozzolino	Using vineyard profiling to predict red grape quality	AWRI Roadshow, McLaren Vale, SA	17 June 2009
P.R. Dry	Great wine from grafted vines		
	Alternative grape varieties		
M. Essling	Vineyard management strategies for a hotter future		
P.J. Costello	Use of lysozyme to control malolactic bacteria during winemaking		
D.L. Capone	The ability of various wine bottle closures and fining agents to remove flavour and aroma compounds from wine		
P.A. Henschke	Natural fermentation: Potential of alternative inoculation strategies?		
J.R. Bellon	New hybrid wine yeast that impart diverse flavours and aromas		



Staff	Title of talk	Presented to and where	Date
E.J. Waters	Oxygen ingress into wine bottles	AWRI Roadshow, McLaren Vale, SA	17 June 2009
E.J. Bartowsky	Wine aroma and flavour development by <i>Oenococcus oeni</i> during malolactic fermentation	Winemakers, Black Stallion Winery, Napa Valley, USA	18 June 2009
		Napa Valley winemakers, Safari West Wildlife Foundation, Napa Valley, USA	19 June 2009
I.S. Pretorius	Yeast and wine: where we were, where we are and where we're going	Lallemend meeting, Bordeaux, France	20 June 2009
W.U. Cynkar	Grape and wine quality – what to measure and how to do it	AWRI Roadshow, Langhorne Creek, SA	22 June 2009
A.D. Coulter	Taints and off-flavours in wine – case studies of recent industry problems		
P.R. Dry	Understanding how vines cope with hot weather and extended drought conditions		
	Cultural practices to improve fruitset		
	Vineyard management strategies to improve wine quality		
M. Essling	Vineyard management strategies for a hotter future		
	Sustainable salinity management in your vineyard		
P. Osidacz	Defining flavour preferences of Chinese red wine consumers		
G.D. Cowey	Wine taint prevention and methods to assess taints in winemaking additives	AWRI Roadshow (workshop), Langhorne Creek, Vic.	23 June 2009
M.G. Holdstock	The avoidance of taints and chemical instabilities during winemaking - case studies		
	A tasting of real wines with 'real' taints		
A.D. Coulter	A tasting of wines with simulated taints and faults		
	The avoidance of taints and chemical instabilities during winemaking		
	Instabilities from wine additives		
G.D. Cowey	Methods to assess taints in winemaking additives		
D. Cozzolino	Smart technologies for process control: are we there yet?	Wine Engineering Australia Conference, Barossa, SA	24 June 2009
P.A. Smith	Effects of ageing on the compositional and physicochemical properties of red wine tannin fractions	American Society of Enology and Viticulture (ASEV), Napa Valley, California, USA	
C.A. Simos	The role of the AWRI and innovation in the Australian wine sector	Associazione Enologi Enotecnici Italiani Vini Trendi, Soave, Italy	25 June 2009
E.J. Bartowsky	Influence of the wine microflora on sensory characteristics in Cabernet Sauvignon	ASEV conference; International Cabernet Symposium, Napa Valley, USA	26 June 2009
I.S. Pretorius	Microbial genomics, transcriptomics, proteomics and Metabolomics: what does it all mean for wine economics?	32 nd World Congress on Vine and Wine and the 7 th General Assembly of the OIV, Zagreb, Croatia	29 June 2009
M. Ugliano	Wine development post-bottling: update on 2009 trials	Nomacorc Post Bottling Chemistry Program Meeting, ENSAM, Angers, France	30 June 2009



Appendix 1 – External presentations and talks

Posters

Author(s)	Title of poster	Presented at	Date
A.R. Borneman, A.H. Forgan, P.J. Chambers, I.S. Pretorius	Genome sequencing and comparative genomics of a wine strain of <i>Saccharomyces cerevisiae</i>	2008 Yeast Genetics and Molecular Biology Meeting, Toronto, Ontario, Canada	22 - 27 Jul 2008
J.R. Bellon, M.A. de Barros Lopes ¹ , A.R. Borneman, P.J. Chambers	Interspecific hybrids of <i>Saccharomyces</i> yeast show evidence of stress-induced genomic instability		
A.R. Borneman, J. McCarthy, E.J. Bartowsky	Comparative genome analysis of different <i>Oenococcus oeni</i> strains	9th Symposium on lactic acid bacteria: Health, evolution and systems biology. Egmond aan Zee, The Netherlands	31 Aug – 4 Sept 2008
P.J. Costello, E.J. Bartowsky, S. Krieger-Weber ² , A. Markides ² , I.L. Francis, B. Travis	Influence of malolactic fermentation on the sensory and chemical properties of Cabernet Sauvignon wine		
S.-J. Bell, M. Essling, R. Correll ⁵	Manipulating nitrogen in the vineyard: grape and wine colour	8th International Symposium on Grapevine Physiology and Biochemistry, Adelaide, SA	24 – 28 Nov 2008
D.W. Jeffery, K.H. Pardon, M.A. Sefton, G.M. Eusey ³ , B. Fedrizzi ⁶	Identification of 4-S-glutathionyl-4-methylpentan-2-one from Sauvignon Blanc must: A potential precursor to the important volatile thiol aroma compound 4-MMP	RACI Organic08, Hobart, Tas.	7-12 Dec 2008
A.L. Fudge, G.M. Eusey ³ , Y. Hayasaka, K.L. Wilkinson ³	LC-MS/MS SIDA method for the quantitative analysis of the likely precursor to cis-oak lactone in oakwood		
D.W. Jeffery, P.A. Smith, M.J. Herderich	Challenges in natural products chemistry – characterisation of red wine polyphenols		
J.R. Bellon, M.A. de Barros Lopes ¹ , B.L. Dunn ⁴ , A.R. Borneman, P.J. Chambers	Interspecific hybrids of <i>Saccharomyces</i> yeast show evidence of stress-induced genomic instability	Lorne Genome Conference, Lorne, Vic.	15-18 Feb 2009
P.J. Costello, E.J. Bartowsky, S. Krieger-Weber ² , A. Markides ² , I.L. Francis, B. Travis	Influence of malolactic fermentation on the sensory and chemical properties of Cabernet Sauvignon wine	ASEV Conference, Napa Valley, USA	23-26 June 2009

1. University of South Australia, 2. Lallemand, 3. University of Adelaide 4. Stanford University Medical Centre, 5. Rho Environmetrics, 6. University of Padova



Appendix 2 – Teaching responsibilities of the AWRI staff during 2008/2009

Subject	No. of lectures	AWRI staff
Semester 2 2008		
The University of Adelaide		
3045WT/7048WT Advances in Oenology	3	E.J. Bartowsky
	4	P.A. Henschke
	1	C.A. Simos
3046WT Fermentation Technology	1	I.L. Francis
	2	P.A. Henschke
7004WT Wine packaging and quality management	1	E.J. Waters
Flinders University		
BTEC 3630 Medical and Molecular biotechnology	1	S.A. Schmidt
MMED 3921 Industrial and Pharmaceutical Microbiology	2	P.A. Henschke
BTEC 9671 Bioprocessing and Industrial Biotechnology	2	
Semester 1 2009		
The University of Adelaide		
7010WT Stabilisation and Clarification	3	E.J. Waters
3007WT Stabilisation and Clarification	3	A.D. Coulter
2001WT/7030WT Wine in Society	2	C.S. Stockley
3005WT/7008WT Grape Industry Practice Policy and Communication	6 weeks (subject coordination and lectures presented) Approximately 50 hours	C.S. Stockley
3047/7047 Winemaking at vintage	1	M.G. Holdstock
	3	G.D. Cowey
	2	P.A. Henschke
	4	P.W. Godden
University of Tasmania		
KLA100 Introduction to Agriculture and Horticulture	1	R.G. Dambergs



Appendix 3 – Student supervision responsibilities of the AWRI staff for 2008/2009

Student	Supervisors	Source of funds
PhD		
D.L. Capone	M.A. Sefton ² , D. Jeffery	AWRI
E. Dennis	P.A. Smith, M.V. Perkins ⁴	GWRDC/APA
J. Gill	J. Jones ⁸ , R.G. Dambergs	University of Tasmania, APA, Tasmanian Pinot Forum
J. Hixson	G.B. Else ² , C.D. Curtin	University of Adelaide
F. Kerslake	J. Jones ⁸ , R.G. Dambergs, D. Close	University of Tasmania, ICIP
E. King	C.D. Curtin, I.L. Francis, I.S. Pretorius, S. Bastian ²	GWRDC
S. Nordestgaard	E.J. Waters, C. Colby ¹¹ , B.K. O'Neill ²	APA/GWRDC
C. Payne	S. Bastian ² , P. Bowyer ¹⁰ , M.J. Herderich	GWRDC
T. Tran	P.J. Chambers, G. Stanley ⁷	Victoria University and AWRI
S. Van Sluyter	E.J. Waters, F. Pettolino, A. Bacic ⁹	Melbourne University/AWRI
G. Winter	M. Ugliano, C.D. Curtin, V. Higgins ³	University of Western Sydney, Laffort Oenologie
N. Warnock	S. Schmidt, E.J. Waters, Peter Anderson ⁴	Flinders University/AWRI

Masters		
E. Cooter	R. Muhlack, P. Ashman ² , P. van Eyk ²	University of Adelaide
S. Holt	P. Anderson ⁴ , A.G. Cordente, C.D. Curtin, J.H. Swiegers ⁵ , J. Winther ⁶	Chr. Hansen A/S, Flinders University

Hons		
A. Betteridge	C.D. Curtin, P.J. Godden, M.A. de Barros Lopes ¹	University of South Australia
R. Kilday	K. Wilkinson ² , C.D. Curtin	University of Adelaide
G. Langhans	P.Grbin ² , C.D. Curtin	University of Adelaide

1. University of South Australia; 2. University of Adelaide; 3. University of Western Sydney; 4. Flinders University; 5. Chr. Hansen; 6. University of Copenhagen; 7. Victoria University; 8. University of Tasmania; 9. Melbourne University; 10. Laffort Australia; 11. Arup

Theses completed

Student	Hon/PhD	Title of Thesis	Supervisors
V. Joscelyne	PhD	Consequences of extended maceration for red wine colour and phenolics	C. Ford, S. Bastian ¹ , G. Jones, M.J. Herderich
D. Kutyna	PhD	Isolation of low ethanol yeast strains using adaptive evolution	P.J. Chambers, P.A. Henschke, C.A. Varela and G. Stanley ³
A. Oberholster	PhD	Investigation of the chemical and sensory properties of wine pigments	E.J. Waters, I.L. Francis, P. Iland, G.P. Jones ¹
A. Betteridge	Hon	Uptake of hydroxycinnamic acids by <i>Dekkera bruxellensis</i>	C.D. Curtin, P.W. Godden, M.A. de Barros Lopes ²
N. Chee Ming	Hon	Modelling of wine barrel heat transfer during sterilisation	
G. Langhans	Hon	The impact of Australian <i>Dekkera bruxellensis</i> isolates on wine quality	P. Grbin ¹ C.D. Curtin
R. Kilday	Hon	The effect of fermentation on methoxypyrazines	K. Wilkinson ¹ , C.D. Curtin
T.B. van Heeswijck	Hon	Dynamic simulation of wine fermentation	R. Muhlack, B.K. O'Neill ¹

1. University of Adelaide; 2. University of South Australia; 3. Victoria University



Appendix 4 – Media interviews during 2008/2009

Date	Staff member	Discussed	Media
5 Aug 2008	C.S. Stockley	Wine and health research in Australia	Anita Donaldson, <i>Australian and New Zealand Grapegrower and Winemaker</i>
15 Sept 2008	C.A. Varela	Alcohol levels in wine	<i>Australian and New Zealand Grapegrower and Winemaker</i>
2 Sept 2008	G.D. Cowey	Eucalyptus character in wine	Skye Shannon, ABC
3 Sept 2008	I.S. Pretorius	Innovation in the Australian wine industry supported by the AWRI	Chilean TV
9 Sept 2008	C.S. Stockley	Dental health and wine	Tony Love, <i>The Advertiser</i>
2 Oct 2008	C.S. Stockley	Proposed exemption of isinglass from allergen labeling in beer and wine	Leanne Edmiston, <i>Courier Mail</i> , Brisbane
		Additives and processing aids used in Australian winemaking	Caroline Marcus, <i>Sun Herald</i>
3 Oct 2008	C.S. Stockley	Potentially allergenic processing aids in wine	ABC Radio Queensland
8 Oct 2008	I.S. Pretorius	Yeast genome sequencing project	ABC Country Hour
			John Wiseman, <i>The Australian</i>
			Philip White, <i>Independent Weekly</i>
			Sarah Morris, 2UE National Rural News
			2SM News Sydney
			Cameron Green, ABC National Rural News
			Shawn Walker, ABC Brisbane
			Esther Lindstrom, Channel 10 News
			ABC TV News
			Scott Bills, ABC radio
			Jancis Robinson, UK
15 Oct 2008	C.S. Stockley	White wine and health	Sunrise Breakfast Program, Channel 7
15 Oct 2008	C.S. Stockley and E.M. Robinson	Health and safety issues of cork taint and cork-tainted wine	Jo Hegerty, <i>Sunday Life Magazine</i>
16 Oct 2008	P.J. Chambers	Genetically modified organisms in food and beverages	Margie Smithurst, ABC Adelaide
27 Oct 2008	I.L. Francis	Chinese red wine consumer project	John Snow, <i>Decanter</i>
			Sophie McKinnon, ABC radio Canberra
			Margie Smithurst, ABC news
			Community Radio National Radio News
			Candice Marcus, ABC news radio
			Carol Duncan, ABC radio Newcastle
			Tony Keys, <i>The Keys Report</i>
			Lisa Lijie, China Wine News
			Sheryl Kruger, <i>South African Wine</i>
			Jeni Port, <i>The Age</i>
			Red Symons, ABC Melbourne
			Sen Lam, Connect Asia, ABC Radio National
			Meraiah Foley, <i>International Herald Tribune</i>
20 Nov 2008	Y. Hayasaka, G. Baldock, C.A. Simos, M.J. Herderich with K. Wilkinson ¹	Wine Innovation Cluster	<i>The Advertiser</i>
23 Nov 2008	R.G. Dambergs	Tasmanian Node	Graham Philips, <i>Mercury</i>
25 Nov 2008	I.S. Pretorius	Keeping the fine wine ideas flowing	Rachel Lebihan, <i>Australian Financial Review</i>
28 Nov 2008	R.G. Dambergs	The AWRI node	Mark Smith, <i>Australian Viticulture</i>

1. University of Adelaide



Appendix 4 – Media interviews during 2008/2009

Date	Staff member	Discussed	Media
2 Dec 2008	I.S. Pretorius	Yeast genome sequence project	Ben Canaider, <i>The Age</i>
9 Dec 2008	R.G. Damberg	Research program of the AWRI Tasmanian node	Cameron Wilson, ABC <i>The Country Hour</i>
			Sally Glaetzer, <i>The Mercury</i>
			Interview for ABC radio news
10 Dec 2008	Y. Hayasaka, G. Baldock, K. Wilkinson ¹	Wine Innovation Cluster	<i>GrapeGrowers & Vignerons</i>
8 Jan 2009	C.S. Stockley	Resveratrol-enhanced wine	Jamie Goode, <i>Wine Business International</i>
14 Jan 2009	D. Capone	Are wines affected by the proximity of vineyards to Eucalypt trees?	Katherine Lindh, <i>Australian and New Zealand Grapegrower and Winemaker</i>
12 Feb 2009	I.L. Francis	'Minerality' in wine	Sally Easton, <i>The Drinks Business</i> (UK)
13 Feb 2009	C.A. Simos	Smoke taint plus problem solving projects	James Halliday
18 Feb 2009	I.S. Pretorius	The Australian grape and wine sector	Cheese Concepts, French Film Crew
24 Feb 2009	D. Jeffery	Working as a chemist at the AWRI	Karen Harries-Rees, <i>Chemistry World</i>
20 Mar 2009	C.A. Simos	Smoke taint	Norman McFarlane, Independent Journalist, South Africa
23 Mar 2009			Jenny Bates, ABC News, Newcastle, NSW
24 Mar 2009			Simon Evans, Australian Financial Review
			ABC News, Melbourne, Vic
5 Mar 2009	M. Mercurio	Metabolomics Facility	<i>The Advertiser</i> (published 6 March 6 2009)
10 Mar 2009			<i>The Eastern Courier</i> (published 11 March 2009)
5 Mar 2009			Channel Ten News (aired 6 March 2009)
3 Apr 2009	I.L. Francis	Flavour compounds in wines and foods	Huon Hooke, <i>Gourmet Traveller Wine</i>
12 June 2009	C.S. Stockley	Myths about alcohol and wine	Dominique Pile, <i>Food Investigators</i> , SBS
17 June 2009		Alcohol and hangovers	Sarah Berry, <i>Cosmopolitan</i> magazine
30 June 2009		Resveratrol in beer and wine	Gabby Rogers, Channel 9

1. University of Adelaide

Appendix 5 – Published papers by the AWRI staff during 2008/2009

1052 Vilanova, M., Ugliano, M., Henschke, P.A., Pretorius, I.S. Gestión del nitrógeno del mosto en la fermentación. Influencia en la producción de aromas del vino. *Enólogos* 53, 40–45; 2008.

1053 Ugliano, M., Henschke, P.A., Herderich, M.J., Pretorius, I.S. Nitrogen management – critical for wine flavor and style. *Pract. Winery Vineyard* (May/June), 6–25; 2008.

1054 Swiegers, J.H., Saerens, S.M.G., Pretorius, I.S. The development of yeast strains as tools for adjusting the flavor of fermented beverages to market specifications. In: Frenkel, D.H., Belanger, F. (eds.) *Biotechnology in flavour production*. Oxford, UK: Blackwell Publishing: 1–55; 2008.

1055 Ramachandran, N., Joubert, L., Gundlapalli, S.B., Cordero Otero, R.R., Pretorius, I.S. The effect of flocculation on the efficiency of raw-starch fermentation by *Saccharomyces cerevisiae* producing the *Lipomyces kononenkoae* LKA1-encoded α -amylase. *Ann. Microbiol.* 58(1), 99–108; 2008.

1056 Pocock, K.F., Waters, E.J., Herderich, M.J., Pretorius, I.S. Protein stability tests and their effectiveness in predicting protein stability during storage and transport. *Aust. N.Z. Wine Ind. J.* 23(2), 40–44; 2008.

1057 O'Brien, V., Colby, C. The 'Holy Grail' of wine clarification – CMF? *Aust. N.Z. Wine Ind. J.* 23(2), 33–38; 2008.

1058 Jeffery, D.W., Mercurio, M.D., Herderich, M.J., Hayasaka, Y., Smith, P.A. Rapid isolation of red wine polymeric polyphenols by solid-phase extraction. *J. Agric. Food Chem.* 56(8), 2571–2580; 2008.

1059 Gawel, R., Dimanin, P.A.-G., Francis, I.L., Waters, E.J., Herderich, M.J., Pretorius, I.S. Coarseness in white table wine. *Aust. N.Z. Wine Ind. J.* 23(3), 19–22; 2008.

1060 Wood, C., Siebert, T.E., Parker, M., Capone, D.L., Else, G.M., Pollnitz, A.P., Eggers, M., Meier, M., Vössing, T., Widder, S., Krammer, G., Sefton, M.A., Herderich, M.J. From wine to pepper: rotundone, an obscure sesquiterpene, is a potent spicy aroma compound. *J. Agric. Food Chem.* 56(10), 3738–3744; 2008.



- 1061** Siebert, T.E., Wood, C., Else, G.M., Pollnitz, A.P. Determination of rotundone, the pepper aroma impact compound, in grapes and wine. *J. Agric. Food Chem.* 56(10), 3745–3748; 2008.
- 1062** Pardon, K.H., Graney, S.D., Capone, D.L., Swiegers, J.H., Sefton, M.A., Else, G.M. Synthesis of the individual diastereomers of the cysteine conjugate of 3-mercaptohexanol (3-MH). *J. Agric. Food Chem.* 56(10), 3758–3763; 2008.
- 1063** Bartowsky, E., Costello, P., McCarthy, J. MLF – adding an ‘extra dimension’ to wine flavour and quality. *Aust. N.Z. Grapegrower Winemaker* 533a, 60–65; 2008.
- 1064** Muhlack, R. Engineering fermentation. *Aust. N.Z. Grapegrower Winemaker* 536, 83–90; 2008.
- 1065** Herderich, M.J., Pretorius, I.S. Sniffing out Shiraz’s secret. *Aust. N.Z. Wine Ind. J.* 23(4), 21–23; 2008.
- 1066** Jones, P.R., Gawel, R., Francis, I.L., Waters, E.J. The influence of interactions between major white wine components on the aroma, flavour and texture of model white wine. *Food Qual. Pref.* 19(6), 596–607; 2008.
- 1067** Low, L.L., O’Neill, B., Ford, C., Godden, J., Gishen, M., Colby, C. Economic evaluation of alternative technologies for tartrate stabilisation of wines. *Int. J. Food Sci. Tech* 43(7), 1202–1216; 2008.
- 1068** Wirthensohn, M.G., Chin, W.L., Franks, T.K., Baldock, G., Ford, C.M., Sedgley, M. Characterising the flavour phenotypes of almond (*Prunus dulcis* Mill.) kernels. *J. Hort. Sci. Biotech* 83(4), 462–468; 2008.
- 1069** Skouroumounis, G., Waters, E. Oxygen ingress into bottled wine. *Pract. Winery Vineyard July/August*, 6–14; 2008.
- 1070** Bartowsky, E.J., Henschke, P.A. Acetic acid bacteria spoilage of bottled red wine—a review. *Int. J. Food Microbiol.* 125(1), 60–70; 2008.
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Appendix 5 – Published papers by the AWRI staff during 2008/2009

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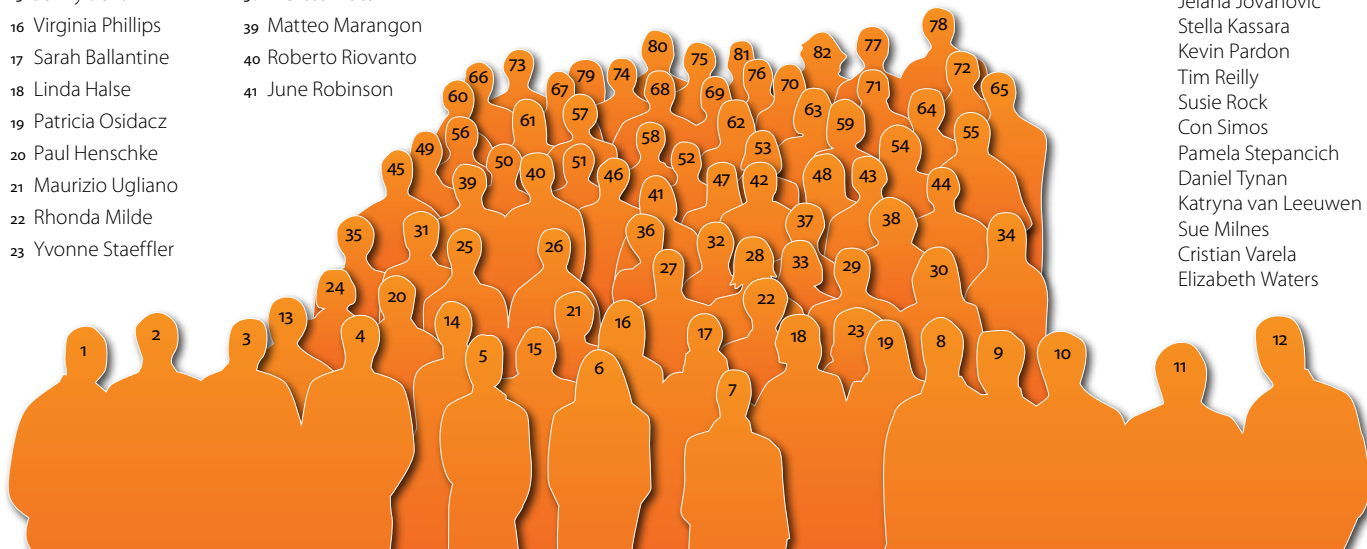
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